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## **MODERNIZATION OF PRODUCTION PROCESSES BY MILK PROCESSING ENTERPRISES OF UKRAINE AS A FACTOR IN INCREASING THE COMPETITIVENESS OF PRODUCTS**

### **Introduction**

In the conditions of constant competition, the ability to create and maintain leading positions in the market is possessed by only those enterprises that are able to constantly improve their characteristics, optimize their internal capabilities, as well as continuously increase the productivity and quality of the results of their activities, and milk processing enterprises are no exception.

The dairy industry is one of the most intensive, dynamic and important components of the agro-industrial complex of Ukraine. In recent years, the process of modernization and introduction of the latest technologies is actively taking place at domestic milk processing enterprises, high-tech productions are being developed, capacities are being increased, which brings the production of products closer to European standards, makes it possible to reduce the costs of raw materials, expand the range of products and produce high-quality dairy products. All this becomes possible precisely due to scientific research and innovative developments of both foreign and domestic scientists, because understanding the problem is the first step to solving it [1].

The production activity of any enterprise, including a milk processing one, is aimed at creating conditions for maximizing sales of manufactured products, profitable positioning of products on the market, meeting the ever-growing demands of consumers and, as a result, obtaining high profits. In order to ensure the effective operation of the enterprise, it is necessary to first of all take into account the wishes of consumers, where compliance with the standards of the final product comes to the fore, as well as improving quality and reducing current production costs, which in turn affects the competitiveness of the products themselves.

### **Purpose, subject and research methods**

The purpose of the study is to substantiate the feasibility of implementing innovative technologies and the need to modernize existing technologies by dairy

enterprises of Ukraine, which will allow to minimize production costs, improve the quality of manufactured products, strengthen their competitive advantages in the market, increase their production capacity and income, as well as export manufactured products abroad.

In order to achieve the set goal, it is necessary to solve the following tasks:

- to analyze the dynamics of changes and the structure of the current enterprises of the milk processing industry of Ukraine;
- to research and conduct a rating, for the sake of a generalized understanding of the state of development of the milk processing industry of Ukraine;
- to consider the results of a scientific study on the relevance of using an automatic system for washing the milk line of milking plants, in which, due to the installation of additional elements, it is possible to quickly determine the state of contamination of the milk line and accordingly automatically change its mode parameters, which will make it possible to perform the corresponding technological process with higher productivity, quality and resource conservation;
- conduct a production inspection and economic evaluation of the efficiency of the developed automated system for washing the milk lines of milking plants.

The subject of the study is theoretical, scientific-methodical and practical approaches to the innovative development of enterprises in the milk processing industry.

The research used such methods as: analysis; synthesis; comparison; economic and statistical; prognostication; tabular; graphic, etc.

### **Results of the research**

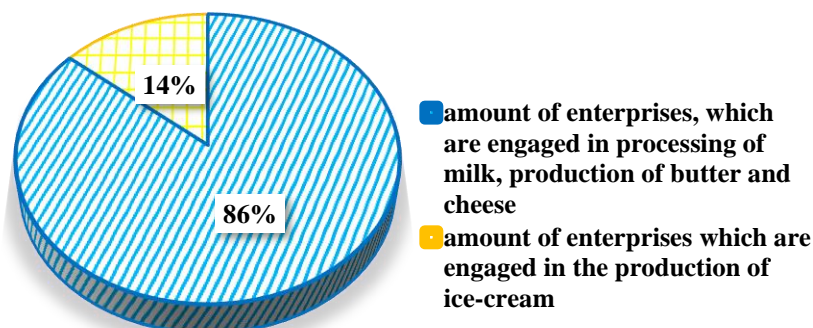
It is worth speeding up the dynamics (Table 1) and structure (Fig. 1) of the active enterprises of the milk processing industry of Ukraine.

**Table 1. The number of active business entities in the milk processing industry in Ukraine in 2011-2020**

Indicator	Years										Divergence 2020/2010 (+,-)
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Number of active business entities, total, units	587	583	641	655	675	649	670	709	730	734	147
Including natural entities-entrepreneurs, units	146	166	174	254	283	294	290	308	318	340	194
in % to the total of business entities of corresponding type of economic activity	24,9	28,5	27,1	38,8	41,9	45,3	43,3	43,4	43,6	46,3	21,4

*Source: calculated by the authors according to [2].*

Having analyzed the dynamics of changes in the number of active business entities in the milk processing industry, it can be emphasized that over the last decade there has been a clear trend of growth of such enterprises, an increase of 147 enterprises in 2020 compared to 2011. It is worth noting that the rapid growth in the studied period is among individual entrepreneurs among all milk processing enterprises, their number increased in 2020 on 194 farms compared to the same indicator in 2011.



**Fig. 1. The structure of the number of active business entities in the milk processing industry in Ukraine, 2020**

*Source: calculated by the authors according to [2]*

Having studied the structure of the number of active business entities in the dairy industry in the country in 2020, we can emphasize that the largest share among enterprises engaged in the production of dairy products is occupied by businesses specializing in milk processing, butter and cheese production, 86%, which equivalent to 632 units, the remaining 14% are made by enterprises engaged in the production of ice cream 102 units.

It is expedient to research and rank the number of operating enterprises by region of Ukraine for a general understanding of the state of development of the milk processing industry (Table 2).

**Table 2. Number of active milk processing enterprises by region of Ukraine in 2014-2020**

Region	Units					Divergence 2020/2016 (+,-)	Rating 2020
	2016	2017	2018	2019	2020		
Vinnitsya	47	55	54	49	45	-2	4
Volyn	5	7	8	5	7	2	20
Dnipropetrovsk	36	38	39	42	39	3	7
Donetsk	15	16	22	24	23	8	14
Zhytomyr	26	30	33	34	29	3	9
Zakarpattya	12	11	14	16	15	3	18
Zaporizhzhya	25	24	22	23	24	-1	13
Ivano-Frankivsk	24	25	25	20	20	-4	15
Kyiv	59	45	48	45	41	-18	5
Kirovohrad	6	9	14	14	15	9	18
Luhansk	13	10	10	11	13	-	19
Lviv	32	35	37	41	49	17	3
Mykolayiv	20	18	20	20	18	-2	17
Odesa	29	27	29	26	23	-6	14

Poltava	42	45	42	40	40	-2	6
Rivne	22	21	23	22	24	2	13
Sumy	16	12	11	19	24	8	13
Ternopil	27	25	26	31	30	3	8
Kharkiv	51	57	57	63	61	10	2
Kherson	21	22	24	23	19	-2	16
Khmelnyskiy	28	25	25	27	25	-3	12
Cherkasy	20	21	24	25	26	6	11
Chernivtsi	7	6	6	7	7	-	20
Chernihiv	26	22	26	26	27	1	10
Kyiv city	40	64	70	77	90	50	1
Ukraine, total	649	670	709	730	734	-	-

Source: calculated by the authors according to [2].

Having analyzed the dynamics of changes in the number of active milk processing enterprises in the regions of Ukraine, it can be emphasized that over the past five years there has been a clear trend towards growth in fourteen regions, in particular, the highest indicators of increase are recorded in the city of Kyiv by 50 enterprises in 2020 compared to 2016. It is worth noting that the rating of the number of active milk processing enterprises by region of the country shows that the first five are: Kyiv, Kharkiv, Lviv, Vinnytsia and Kyiv regions.

The increase in the number of milk processing enterprises indicates the relevance and,

therefore, the growth of competition in this field, so business entities are faced with questions about finding opportunities to increase the competitiveness of their products, which in turn is possible through quality improvement and cost minimization. It is the innovative activity of modern milk processing enterprises, in particular the introduction of the latest technologies in production and the modernization of existing production resources, that contribute to the achievement of these goals.

Modern milk processing enterprises will benefit from the installation, which increases the efficiency of the washing system of milking units through the use of air and hydraulic injectors with automated control of their mode parameters depending on the indicators of contamination of the milking equipment. This is extremely relevant, because as a result of bacterial contamination, which is the result of poor performance of the technological operation of washing milking units and the formation of milk deposits on the internal surfaces of the milk duct system, it leads to a decrease in the quality of milk. To increase efficiency and save resources (by reducing the consumption of air, hot water, energy and operating costs), the process of washing milking units should be adaptive on the basis of data obtained from monitoring tools for assessing the condition of the surfaces of the milk-conducting system and the hydrodynamic parameters of the movement

of a two-phase washing solution, which is achieved by using air and hydraulic injectors based on automated control [1, 3-5].

The basis of the invention (patent No. 140923 [6]) is the task of creating such an automatic system for washing the milk line of milking installations, in which, due to the installation of additional elements, it is possible to quickly determine the state of contamination of the milk line and accordingly automatically change its mode parameters, which will make it possible to perform appropriate technological process with higher productivity and quality while reducing water loss and energy consumption.

The state target program for the development of the agrarian sector of the economy for the period until 2022 envisages increasing milk production and improving its quality [7]. Among the quality indicators, as a raw material for further processing, its bacterial contamination is essential. This indicator depends on the sanitary and hygienic condition of milking equipment, timely cooling of milk, requirements and the influence of other external factors. In the process of milking, milk passes through milking machines, milk pipes, milk collectors, individual and group counters, etc., which are a source of bacterial contamination. The recommended conditions for improving the quality of milk are to ensure the efficiency of the milking plant washing process by increasing its duration, which leads to an increase in operating costs (water, detergents, electricity, etc.) and the cost of dairy products. Thus, the creation of automated technical and technological support of the milking plant washing system, which intensifies the process without additional costs, becomes of primary importance in solving the problem of improving the quality of milk.

The most important operation for the care of the milk line of the milking plant and milk equipment is its washing. The main task of washing milking equipment is to remove various impurities (milk residues, dirt, bacterial accumulations and other particles and substances) from its inner surface, which is in contact with milk. Moreover, the milk film and fat are not only a favorable environment for the rapid reproduction of bacteria, but also the cause of premature wear of rubber parts.

The analysis of the factors of the decrease in the quality of milk as a result of bacterial contamination showed that this is the result of poor performance of the technological operation of washing milking units and the formation of milk deposits on the internal surfaces of the milk duct system. As a result of the analysis of the existing constructions of the technical and technological support of washing, it was established that the most effective are the circulation systems of washing with the regulated formation of a traffic jam. To increase efficiency and save resources (by reducing the consumption of air, hot water, energy and operating costs), the process of washing milking units should be adaptive on the basis of data obtained from monitoring tools for assessing the condition of the surfaces of the milk-conducting system and the hydrodynamic parameters of the

movement of a two-phase washing solution, which is achieved by using air and hydraulic injectors based on automated control.

Technical and economic calculations were performed according to the method of economic evaluation of equipment at the test stage, which is the industry standard of Ukraine DSTU 4397:- 2005 [8].

The annual economic effect of ER from the introduction of an automatic system for washing the milk line of milking installations is determined by the formula

$$E_p = \Pi_B - \Pi_H + E_{\text{Я}}, \quad (1)$$

where  $\Pi_B$ ,  $\Pi_H$  – total operating costs for the basic and new variant of the system for washing the milk line of milking plants, respectively, UAH;

$E_{\text{Я}}$  – additional annual economic effect obtained due to changes in the quantity and quality of milk received, UAH.

The annual economic effect obtained due to changes in the quantity and quality of products

$$E_{\text{Я}} = C_{\text{ЯH}} - C_{\text{ЯБ}} \quad (2)$$

where  $C_{\text{ЯБ}}$ ,  $C_{\text{ЯH}}$  – the total cost of milk obtained in the case of the application of the basic and new variant of the system for washing the milk line of milking plants, respectively, UAH.

The total cost of milk is determined by the formula:

$$C_{\text{Я}} = \Pi_P \cdot \Pi_B, \quad (3)$$

where  $\Pi_P$  – annual yield of milk in the farm, l;

$\Pi_B$  – basic price for 1 liter of milk depending on its type, UAH/liter;

Cumulative operating costs are determined by the formula:

$$\Pi_E = \text{З} + \Gamma + B + P + A, \quad (4)$$

where  $\text{З}$  – salary expenses, UAH;  $\Gamma$  – electricity costs, UAH.

$$\Gamma = \Pi_E \cdot E; \quad (5)$$

$E$  – annual electricity consumption of the milking plant during washing, kWh;

$\Pi_E$  – price of 1 kWh electricity, UAH;  $B$  – water consumption during washing, UAH.

$$B = \Pi_E \cdot W; \quad (6)$$

$W$  – annual water consumption during washing, m<sup>3</sup>;

$\Pi_E$  – price of 1 m<sup>3</sup> of water, UAH;  $P$  – maintenance and repair costs, UAH.



$$P = B \cdot (r_{TO} + r_K); \quad (7)$$

B – balanced cost of the milking plant, UAH;

rTO – coefficient of deductions for current repairs and maintenance;

rK – coefficient of deductions for major repairs; A – depreciation expenses, UAH.

$$A = B \cdot r_A; \quad (8)$$

RA – coefficient of deductions for depreciation.

Due to the fact that the basic and the new version of the system for washing the milk line of milking installations do not differ in terms of the number of service personnel and their working hours, in formula (4) we will omit labor costs and rewrite it in the form

$$\Pi_E = \Gamma + B + P + A. \quad (9)$$

The initial data for the technical and economic calculation are presented in the table 3.

**Table 3. The initial data for the technical and economic calculation**

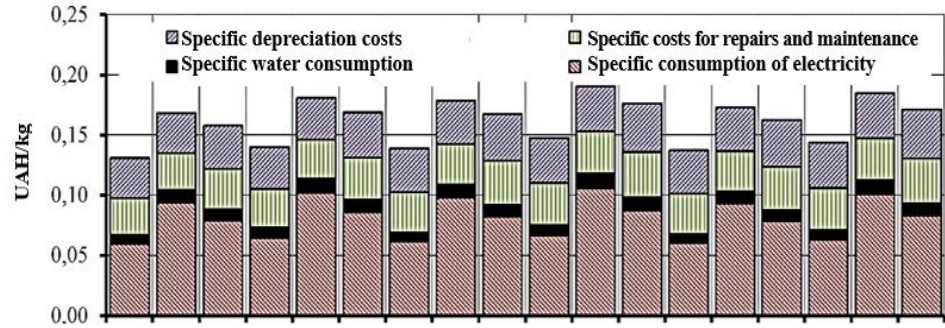
Indicator	Value
Livestock, head	100
Average annual yield from one cow, kg	5000
Lactation period, days	305
Multiplicity of milking	2
Water price, UAH /m <sup>3</sup>	18,45
Electricity price, UAH /kWh	1,90
The price of "Extra" milk, UAH/kg	9,84
The price of milk "High grade", UAH /kg	9,45
The price of "First grade" milk, UAH/kg	9,31

Source: calculated by the authors according to [9].

A graphic presentation of the structure of specific costs of each of the studied options for two types of milking plants is shown in fig. 2–3. The analysis of the figures shows that the total specific costs for the DM-100 "Bratslavchanka" milking unit are higher (0.13-0.19 UAH/kg) than for the DE-16 Yalynka (0.11-0.16 UAH/kg).

Depending on the variety, the value of the obtained milk is formed according to formula (3). Based on the first version of the flushing system (without additional technical and technological

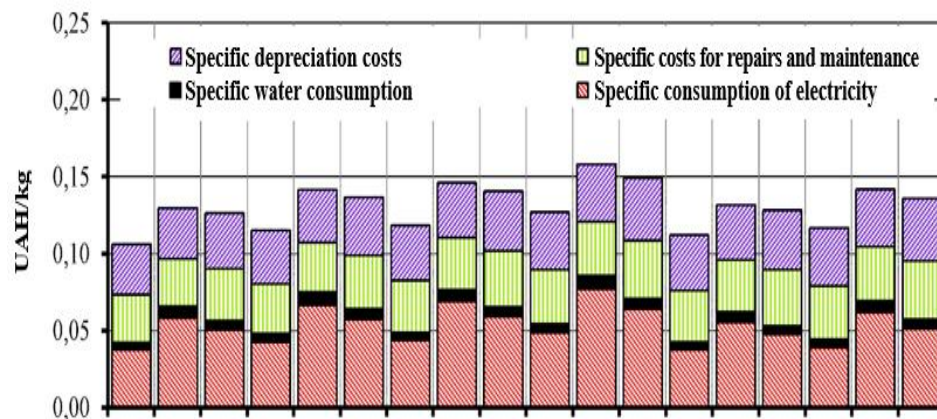
support), we obtain a specific additional economic effect depending on the mode of the flushing system (Fig. 2).



Duration of washing (C)	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive
Modes of hydroinjectors (B)	Disconnected			Connected			Disconnected			Connected			Disconnected			Connected		
Air injector modes (A)	Disconnected						Rational parameters						Adaptive parameters					

**Fig. 2. The structure of specific costs for each of the studied options for the DM-100 "Bratlavchanka" milking plant**

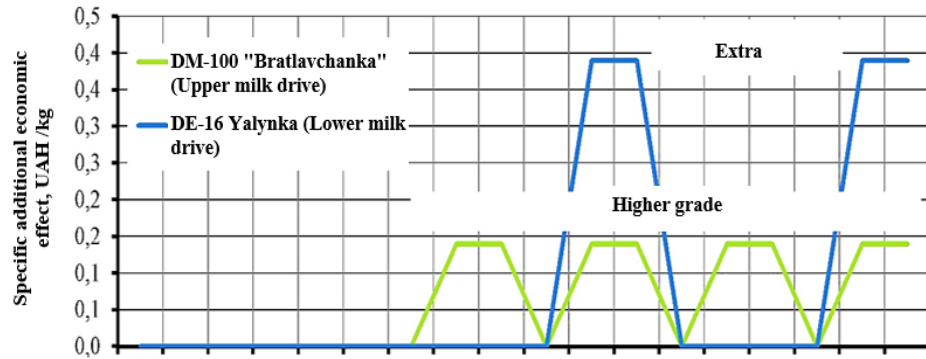
Source: calculated by the authors according to [9].



Duration of washing (C)	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive
Modes of hydroinjectors (B)	Disconnected			Connected			Disconnected			Connected			Disconnected			Connected		
Air injector modes (A)	Disconnected						Rational parameters						Adaptive parameters					

**Fig. 3. The structure of specific costs of each of the studied options for the DE-16 Yalynka milking plant**

Source: calculated by the authors according to [9].

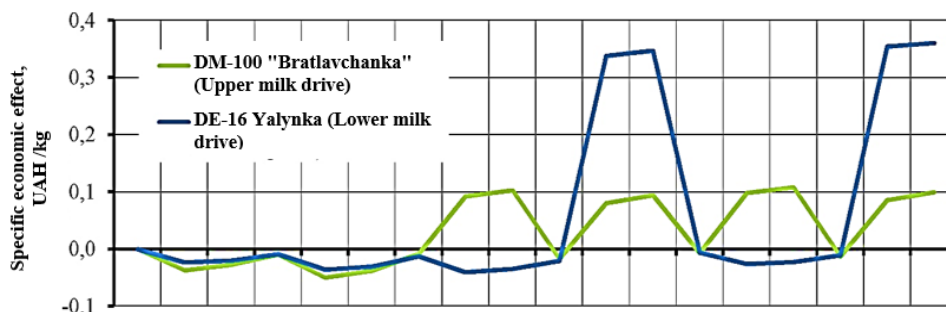


Duration of washing (C)	5 min/10 min/5 min	5 min/30 min/5 min	Adaptive	5 min/10 min/5 min	5 min/30 min/5 min	Adaptive	5 min/10 min/5 min	5 min/30 min/5 min	Adaptive	5 min/10 min/5 min	5 min/30 min/5 min	Adaptive	5 min/10 min/5 min	5 min/30 min/5 min	Adaptive			
Modes of hydroinjectors (B)	Disconnected			Connected			Disconnected			Connected			Disconnected			Connected		
Air injector modes (A)	Disconnected						Rational parameters						Adaptive parameters					

**Fig. 4. Dependence of the specific additional economic effect on the regime of the flushing system**

Source: calculated by the authors according to [9].

Taking the difference of the specific additional economic effect and the specific total costs, we get the specific economic effect (per 1 kg of milk) of using the developed automatic system for washing the milk line of milking units for different modes (Fig. 5).



Duration of washing (C)	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive	5 min/10 min/5	5 min/30 min/5	Adaptive			
Modes of hydroinjectors (B)	Disconnected			Connected			Disconnected			Connected			Disconnected			Connected		
Air injector modes (A)	Disconnected						Rational parameters						Adaptive parameters					

**Fig. 5. Dependence of the specific economic effect on the washing system mode**

*Source: calculated by the authors according to [9].*

From fig. Figure 5 shows that for the DM-100 "Bratslavchanka" milking plant, the absence of an air injector leads to the fact that the operating costs exceed the additional economic effect. And the largest specific economic effect (0.11 UAH/kg) is observed for the variant with adaptive duration of washing and adaptive mode of operation of air injectors when hydraulic injectors are turned off. Indeed, in the given case, the presence of hydroinjectors increases specific operating costs with a slight improvement in milk quality.

A different picture is observed for the DE-16 Yalynka milking unit: the largest specific economic effect (0.36 UAH/kg) is observed for the variant with adaptive duration of washing and adaptive mode of operation of air injectors with connected hydroinjectors.

That is, it can be concluded that for different types of milking plants, it is necessary to use the appropriate modes of operation of the developed automatic system for washing the milk line.

## Conclusions

According to the results of technical and economic calculations, it was established that for the milking unit DM-100 "Bratslavchanka" the greatest specific economic effect (0.11 UAH/kg) is observed for the variant with the adaptive duration of washing and the adaptive mode of operation of the air injectors when the hydroinjectors are turned off. For the DE-16 Yalynka milking unit, the greatest specific economic effect (0.36 UAH/kg) is observed for the variant with adaptive duration of washing and adaptive mode of operation of air injectors with connected hydroinjectors.

The results of the study of the developed installation confirmed the effectiveness of its use, which allows to perform the appropriate technological process with higher productivity and quality while reducing water loss and energy consumption.

It is especially effective to use such developments when creating a new business aimed at the production of dairy products, and this installation will also be useful for existing enterprises when choosing methods for modernizing production. After all, modern economic conditions require milk processing enterprises to react quickly enough to changes in the market situation, to subordinate the enterprise's production to the needs of the market. In our opinion, it is the use of innovative technologies that will contribute to the effective development of milk processing enterprises, which will make it possible to:

- production of higher quality products, higher quality milk;
- reducing the use of resources, which will make it possible to reduce production costs and, as a result, the price of finished products;
- increasing the competitiveness of the product and the enterprise as a whole;
- taking into account the changes in tastes and preferences of consumers, meeting their needs, and as a result, the increase in demand for products;
- positioning its products on the market as high-quality and ecological;
- expansion of sales markets for manufactured products, in particular, their introduction to international markets;
- expanding the production capacity of the business entity and increasing the volume of production;
- compliance of products with international standards, as a result the possibility of exporting their products abroad;
- increase the investment attractiveness of the enterprise, the industry and the country as a whole;
- increase in the company's profit, etc.

## References

1. Aliiev, E.B., Yaropud, V.M., Babyn, I.A. & Buinitsky, O.I. (2021). Results of researches of hydrodynamic system of washing of milking installations. *Engineering, energy, transport of agro-industrial complex*. №4. P. 45-55 DOI: 10.37128/2520-
2. Babyn I.A. The improvement of efficiency of the washing system of milk-making machines: thesis...cand. techn. scienc.: 05.05.11. Vinnytsia, 2020. 235 c.
3. Babyna O., Babyn I. Organization of marketing activities at milk-processing enterprises of Ukraine. *Marketing research of agricultural enterprises: theoretical and practical aspects*. Monograph. Primedia eLaunch, Boston, USA, 2022. P. 72–107.
4. Babyn, I.A., Yaropud, V.M., Hrytsun, A.V., & Pryshlyak, V.M. (2020). Ukrainian utility model patent 140923, IPC A01J 7/02 (2006.01). Automatic system for washing the milk line of milking installations. Applicant: Vinnytsia National Agrarian University, № u201909823. Application 16.09.2019. Publ. 10.03.2020, Bull. No. 5.
5. DSTU 4397. (2005). *Agricultural machinery. Methods of economic evaluation of equipment at the test stage*. Kyiv: Derzhspozhivstandard of Ukraine. 15 p.
6. Gunko, I., Babyn, I., Aliiev, E., Yaropud, V. & Hrytsun, A. (2021). Research into operating modes of the air injector of the milking parlor flushing system. *U.P.B.Sci. Bull., Series D*. Vol. 83. Iss. 2. P. 297-310. SNIP 0,316. Retrieved from: [https://www.scientificbulletin.upb.ro/rev\\_docs\\_arhiva/rez4fb\\_469127.pdf](https://www.scientificbulletin.upb.ro/rev_docs_arhiva/rez4fb_469127.pdf)
7. Gunko, I.V., Babyn, I.A. & Pryshlyak, V.M. (2020). Experimental studies of the modes of operation of the air injector of the milk washing system of the milking parlor. *Scientific horizons*. № 3. P. 44-53.
8. Kaletnik, H.M., Kozlovsky, S.V., Tarasyuk, N.M. & Semenenko, V.V. (2013). *Management of economic relations of enterprises of the dairy subcomplex of the agricultural sector of Ukraine: Monograph*. Vinnytsya. 248 p.
9. State Statistics Service of Ukraine. Retrieved from: <http://www.ukrstat.gov.ua>
10. State target program for the development of the agrarian sector of the economy for the period until 2022. Retrieved from: <https://zakon.rada.gov.ua/laws/show/1437-2015-%D1%80?v=617d3c0773158#Text>

## Abstract

The article examines the relevance and substantiates the need for the introduction of the latest technologies and the modernization of existing production resources by domestic milk processing enterprises. The dynamics of the active enterprises of the milk processing industry of Ukraine over the last ten years were analyzed, and their structure for 2020 was also considered. For a generalized understanding of the state of development of the milk processing industry of Ukraine, the number of operating enterprises by region was studied and ranked. It was determined that the leaders of the milk processing industry are the following regions: Kyiv, Kharkiv, Lviv, Vinnytsia and Kyiv regions. As a result of the stable growth of the number of milk processing enterprises in Ukraine, the competition in the market of dairy products is also increasing, therefore business entities need to actively look for opportunities to increase the competitiveness of their products, and this is possible by introducing the latest and resource-saving technologies into their economic activity. A technical and economic substantiation of the application of the automatic system for washing the milk line of milking units UDM-100 "Bratslavchanka" and UDE-16 "Yalynka" was carried out. It is substantiated that in order to increase the quality of milk, production efficiency and resource saving (by reducing the consumption of air, hot water, energy and operating costs) it is advisable to use the invention, which increases the efficiency of the milking system washing system by using air and hydraulic injectors with automated control of mode parameters of their action depending on indicators of contamination of the milk-conducting equipment.

**Keywords:** milk processing industry, milk processing enterprises, latest technologies, competitiveness, economic effect, technical and economic calculation, production efficiency, resource saving, innovative technologies

*JEL Classification:* D2,