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Prospects for Increasing the Level of Innovation Activity of Dairy Enterprises

Svitlana G. Cheremisina[1], Volodymyr V. Rossokha[2], Mykhailo V. Kryvun[3*]

[1]National Scientific Centre "Institute of Agrarian Economics"
03127, 10 Heroiv Oborony Str., Kyiv, Ukraine

[2]National University "Kyiv-Mohyla Academy"
04070, 2 H. Skovoroda Str., Kyiv, Ukraine

[3]National University of Food Technology
01033, 68 Volodymyrska Str., Kyiv, Ukraine

► **Abstract.** Progressive development of the dairy industry requires improving technologies of feed production, keeping, feeding, increasing livestock and breeding work on farms, the genetic potential of breeds, milking cows, storing and processing milk and producing the necessary range of dairy products. Successful implementation of these technological processes requires an effective system of innovative support for dairy production, for which the scientific developments of the National Academy of Agrarian Sciences of Ukraine are important. At the same time, the ability of dairy enterprises to innovative development is determined by the transformation of their economic mechanism through the introduction of technical, organisational and managerial achievements in the field of technology. The purpose of the article is to study the current realities, opportunities and forecast the main dimensions for the intensification of innovative activities of dairy enterprises in Ukraine. A number of methods were used in the research process: monographic; comparative analysis; prognostication; tabular; settlement and constructive; graphic, abstract-logical. The existence of an adapted system of innovative support is established and scientific developments of control in the selection of raw milk, vitamin naturalisation of milk, technologies of production of dietary dairy products, automation of production processes, heat treatment of milk using modern packaging materials to extend its shelf life, introduction of innovative methods in operational activities, personnel development, marketing and logistics, the use of which should be extended in the system of economic mechanism of functioning and development of the dairy industry. The forecast indicators of the raw material base of the dairy industry of Ukraine, which in 2025 will remain at the level of 2020 and will amount to 9287 thousand tons, with an increase in milk production in agricultural enterprises by 13.0% and a decrease in households by 5.0%. The necessary volumes of raw material production have been established to ensure the production capacity of milk processing enterprises and the rational norm of consumption of milk and dairy products. The dynamics of forecast indicators of dairy production in Ukraine is constructed. The priority target guidelines of the strategy of intensification of innovative activity of milk processing enterprises are substantiated. An algorithm for increasing the innovative activity of a processing enterprise is proposed. These approaches and research results can be used by public and sectoral authorities in the organization of monitoring and development of priority measures to intensify the innovative activities of Ukrainian dairy industry

► **Keywords:** milk, dairy products, innovations, production, processing

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*Corresponding author

Introduction

It is possible to provide the population with dairy products only under the condition of stable and balanced development of the market of milk and products of its processing. The functioning of the dairy market affects the state of production, the development of market infrastructure, the effectiveness of market mechanisms, innovative processes of development of the dairy industry. Increasing raw milk for the dairy industry and quality dairy products for the population requires a radical technological restructuring of the industry. However, dairies with different depths of processing of raw materials and structure of final products have different opportunities for the implementation of innovative projects. With a low level of milk processing and a lack of own funds, small and medium-sized enterprises are left with the function of warehouses for the movement and storage of raw milk. An important task is the modernisation and rational use of production capacity of dairy enterprises.

The concept of innovation and its features in the dairy industry are considered in the works of Ukrainian and foreign scientists. The essence and features of innovative technologies in dairy farming are studied by I.I. Cherven [1], J. Shudlurski, S. Zaika, O. Gridin [2], P. Putsenteilo, V. Nyanko, V. Karpenko [3]. The authors of the publications prove that innovative activity in the conditions of rapid development of the competitive environment and unstable positions of the dairy industry is the foundation for ensuring the profitability of milk production. State policy in the dairy sector should be aimed at supporting research into innovative technological processes and their large-scale development. The experience of introducing innovative approaches in the dairy industry shows the high efficiency of knowledge-intensive and research innovations. The use of innovative technologies and innovative principles of production management is the key to bringing the dairy industry out of the pre-crisis state. On the modern problems of development of the dairy industry focused their research V.L. Karpenko [4], V.M. Tsikhanovskaya [5], W.W. Jejula [6], S. Shupyk [7].

O. Petrichenko outlines the issues of innovation and investment support of the raw material base of the dairy industry, introduction of scientific developments, state support of the dairy industry, investments to increase milk production. It is established that the decrease in innovation activity of enterprises does not correlate with the dynamics of investment processes, which indicates a weak innovation orientation of investment and leads to the accumulation of physically and morally obsolete equipment [8]. Management of technological development of the dairy industry is developed by A. Fenenko [9]. A. Shust, A. Varchenko, and I. Paska take care of the substantiation of the strategy of innovative development of milk production enterprises [10]. Innovative factors and prospects for increasing the competitiveness of the dairy industry are studied by O. Kruglyak [11], M. Parkhomets, L. Uniyat [12], O. Stets [13]. Some aspects of increasing the level of intensification during milk production are considered by V. Kolosha [14], V. Radko [15] D. Simo, L. Mura, J. Buleca [16], V. Maciuc, M. Şteofil, V. Domnica and others [17]. M.I. Ulla highlights the increase of innovation potential on dairy farms through the exchange of knowledge; B.A. Hamid, Kamal; A. Shahzad; Mahmoud, Zeeshan. The authors hypothesised that trust, motivation, training and development are related to the exchange of knowledge between employees and managers and have a positive impact on the innovative capacity of dairy farms [18]. Stimulating the small dairy market and improving livestock feed through local innovation platforms T. Ravichandran, N. Teufel, F. Capezzone, R. Birner, A.J. Duncan. Scientists have studied the changes in small-scale production and marketing of dairy products conditioned upon the creation of a series of innovative platforms. The links between the processes and results of the innovation platform, the use of systematic documentation of results and the identification of factors of influence [19]. Determinants of sustainable innovation of small dairy farmers are set by S. Chindime, P. Kibwika, M. Chagunda, P. Gonzalez-Redondo who proved that for effective and sustainable innovation management, a clear policy should be put in place to provide formal structures to maintain innovation continuity through improved social networks between farmers and cost-effective mechanisms for accessing quality resources [20].

Methodological and practical aspects of a comprehensive study of the state and substantiation of prospects for increasing the level of innovation activity of dairy enterprises have been further developed.

Materials and Methods

Comprehensive and in-depth study of innovative processes in the dairy industry to detail the current level of innovative tools and the choice of promising areas for improvement of milk production and processing technologies was conducted using the monographic method. Comparison of actual and projected indicators of livestock and productivity of cows and milk production in agricultural enterprises and households and production of dairy products in the range was carried out based on collected statistical and forecast data by comparative analysis. A tabular method was used to visualise the results of the study. Determination of forecast indicators of raw material production to ensure a rational consumption of milk and dairy products was carried out by the calculation and design method. The construction of the algorithm for increasing the innovative activity of the dairy processing plant was carried out by the graphical method. The conclusions are formulated by the abstract-logical method.

To determine the forecast indicators of the development of the raw material base of the dairy industry and substantiate the prospective measurements of dairy production by Ukrainian processing enterprises until 2025, forecasting tools using trend extrapolation were used. The methodology of the study can be structured as the following algorithm.

1. The forecast of the theoretical number of cows in agricultural enterprises is built on a logarithmic trend using the formula (1):

$$y = a\ln(x) + b \quad (1)$$

where y is the projected value of the cow population in agricultural enterprises; a and b are constants.

2. The forecast of the theoretical number of cows in households and the inflow of milk to processing enterprises from commodity farms is built on an exponential trend using the formula (2):

$$y = ae^{bx} \quad (2)$$

where y is the forecast values of the number of cows in households and the amount of milk received by processing enterprises from commodity farms; a and b are constants, e is the basis of the natural logarithm.

3. Equalisation of actual indicators of dynamics and development of the forecast of levels of productivity of cows in agricultural enterprises and households, and also the forecast of theoretical receipt of milk on processing enterprises from agricultural enterprises is carried out by means of polynomial function with use of the formula (3):

$$y = a_0 + a_1x + a_2x^2 + \ldots + a_nx^n \text{ for } n\leq 6 \quad (3)$$

where a_0, a_1, a_2, ... a_n are constants.

It should be noted that the polynomial trend of the second degree was used for these forecasts during the study.

$$y = a_1x^2 + a_2x + a_3 \quad (4)$$

where y – projected values of productivity of cows in agricultural enterprises, households and milk supply to processing enterprises from agricultural enterprises; and_1, and_2, and_3 – calculated coefficients.

4. The following systematised tools for trend approximation were used to develop forecast parameters of natural volumes of dairy production in Ukraine (Table 1).

Table 1. Methodical tools for calculating the forecast parameters of dairy production in Ukraine

Type of dairy products	Type of trend approximation	Modeling formula
Processed liquid milk	polynomial of the 2nd degree	$y=a_1 \cdot x^2+a_2 \cdot x+a_3$
Milk (and cream) for baby food is condensed and sugar-free	Stagnant	$y=ax^b$
Milk and cream with a fat content of more than 6%	Stagnant	$y=ax^b$
Milk and cream dry	Exponential	$y=ae^{bx}$
Butter	Polynomial of the 3rd degree	$y = a_1 \cdot x^3+a_2 \cdot x^2+a_3 \cdot x+a_4$
Fresh unfermented cheese	Logarithmic	$y=aln(x)+b$
Sour milk cheese and baby food products	Linear	$y=ax+b$
Rennet cheeses	Stagnant	$y=ax^b$
Cream cheese	Polynomial of the 2nd degree	$y=a_1 \cdot x^2+a_2 \cdot x+a_3$
Milk and cream, condensed or with added sugar	Polynomial of the 2nd degree	$y=a_1 \cdot x^2+a_2 \cdot x+a_3$
Yogurt, kefir, sour cream	Polynomial of the 2nd degree	$y=a_1 \cdot x^2+a_2 \cdot x+a_3$
Fermented milk products for baby food	Exponential	$y=ae^{bx}$

Source: formed based on the results of the author's own research

The empirical basis of the study consists of reports of the National Academy of Agrarian Sciences of Ukraine, statistical materials and official websites of enterprises of milk processing companies of Ukraine.

▸ Results and Discussion

Ensuring a purposeful vector of progressive development of the dairy industry should be considered as a comprehensive, traceable at each stage and systemically interdependent algorithm. Thus, the priority areas of development of dairy enterprises and the industry in general focus on the following areas, taking into account the sequence of the organisational and technological chain. It includes the development of selection and breeding work on farms, increasing the genetic potential of breeds, increasing the number of livestock; improvement of technologies for growing, keeping, feeding and milking cows; improvement of milk storage and processing technologies; introduction of innovative technologies of milk production.

Successful implementation of these technological processes requires an adapted system of innovation.

In the process of research the most thorough scientific developments are systematised, the use of which should be spread in the system of economic mechanism of functioning and development of the dairy industry (Table 2).

Table 2. Innovative tools for the development of the dairy industry of Ukraine

No. s/n	Directions for improving milk storage and processing technologies
1	The method of selection of raw milk for the production of sour milk cheese on the basis of its quality by introducing enzyme preparations at a temperature of 35°C and determining the clotting time of milk in minutes. The rawness of raw milk is preliminarily assessed by its quality and safety – somatic cell content and bacterial contamination, which increases the selection of raw milk for the production of sour milk cheese, using milk-containing enzyme preparations (MEP) of plant or microbial origin
2	The method of vitamin naturalisation of functional milk is to include in the main diet of lactating cows a premix, which additionally introduces vitamin E in the amount of 490 mg/live/day, which allows to increase the concentration of vitamin E in milk to 0.245-0.05 mg/100 g, and reduce the number of somatic cells to 500 thousand/cm^3 , which meets the requirements of first grade milk. The claimed method is cost-effective and simple in technical implementation and production conditions
3	Technology of production of low-lactose fermented milk products for children and adults. The technical conditions apply to the production of fermented milk products, which are produced from normalized milk mixture of milk and demineralised whey obtained by nanofiltration with a demineralization level of 30% and above, in which lactose is partially hydrolysed (broken down into glucose and galactose) by lactase made on pure crops. The technology saves up to 50% of whole milk through the use of liquid or reconstituted demineralised whey
4	Technology of production of sour-milk product «Vitalakt» for special dietary baby food. The technology of fermented milk product has been developed, the functional orientation of which is conditioned upon the presence of probiotic microflora, which contributes to the positive impact on the gastrointestinal tract of the child and allows to recommend it for feeding children of early, preschool and school age. The technology has no world analogues
5	Technologies for the production of new types of cheese, which allows to ensure their high biological and nutritional value with guaranteed quality and safety. The technology allows to save up to 5% of raw milk conditioned upon the fuller use of milk components

Source: based on data [21-23]

The Institute of Food Resources of NAAS is actively working on a comprehensive solution to the problem of technological development of milk production, using modern advanced solutions and best practices in the dairy industry. Developed high-efficiency energy-saving equipment expands the range of its use in the manufacture of cheese, mayonnaise, pasta, butter and other fat-based products.

Thus, enterprises of Ukraine and other neighboring countries purchased more than 200 oil generators of the Ya5-OMS brand, emulsifiers of the Ya5-OEV series for the production of homogenized dairy and fat products and processed cheese. Innovative block-modular units for high-temperature pasteurization of Ya5-ORP cream and Ya5-OPS milk-fat mixtures provide stable and efficient heat treatment of viscous products and reduce energy costs by more than 3 times [21].

Automated installations of the Ya5-OMS-M brand for production of butter, spreads and margarine are a series of universal installations for production of all types of fatty products with fat content from 50 to 82% both with a liquid consistence with packing filling in big transport container, and with firm consistency followed by packing in the form of briquettes. The development is aimed at the production of new Ukrainian technological equipment for the production of oil and other fatty products, which improve production conditions and provide a significant increase in productivity. Results from the implementation: reduction of specific metal content by 5%, reduction of the area by 35, reduction of repair and maintenance costs by 15%, large effective heat transfer area. The equipment allows creating modern technological lines that improve production conditions and provide a significant increase in productivity. According to technical indicators, the equipment is not inferior to world analogues [22].

The development of an installation for pasteurisation of fat mixtures of spreads is aimed at intensifying pasteurisation processes and reducing their energy consumption. The determining factor was the new design of the pasteurizer and its hydrodynamic characteristics, which ensure minimal energy costs and stable and efficient pasteurisation. The economic feasibility of development focuses on reducing electricity costs by 2.5 times. To save heat resources in the stages of heating fat mixtures before pasteurisation, the regenerative heat of the pasteurised product is used. This saved up to 60% of thermal energy. This development has no world analogues [23].

The original design of 5-OSZh cheese makers and their cutting and mixing tools (mixers) allow increasing the yield of cheese grain by 3-5% with its high quality and minimum cheese dust content. The control system allows controlling the operation of the device in automatic, semi-automatic and manual control modes. The economic feasibility of development is to reduce raw material costs and increase the yield of the finished product by 3-5%, reduce the cost of thermal energy for production to 10% and electricity to 2%. Development at the level of world analogues [23].

The set of cheese-making farm of the Ya5-OKS brand is intended for production of all types of cheeses in the conditions of farm cheese-making shops with a capacity from 1000 to 3000 l of processing of milk a day. The development helps to reduce the cost of raw materials and increase the yield of

the finished product by 3-5%, reduce the cost of thermal energy for production up to 10% and electricity up to 2%.

The original design of the devices allows to increase the yield of cheese grain by 3-5% with its high quality and minimum cheese dust content. The control system allows controlling the operation of the device in automatic, semi-automatic and manual control modes. The level of development corresponds to the level of world analogues [22].

Thus, the scientific institutions of the National Academy of Agrarian Sciences of Ukraine provide innovative development of both the raw material base and the field of milk processing. Scientific developments and practical achievements are closely interconnected and allow influencing the processes of stabilisation and further development of the dairy industry. Systematic formation and strategic purposefulness of their use can create a positive synergetic effect.

At the same time, it is expedient to establish real prospects for the development of the raw materials industry in the current trends and optimistic forecasts.

To analyse the trend based on the time series of actual livestock, productivity of cows and milk supply to dairy enterprises in agricultural enterprises and households and build a forecast considering the patterns of the previous 16-year period (2006-2021), used dependence (trend equation) (5):

$$y = f(t) + \xi_t \quad (5)$$

where $f(t)$ – determined non-random component of the process (phenomenon); ξ_t – stochastic random component of the process.

Among the objective patterns for the period 2006-2021, which were established during the study and considered in the construction of forecast models, we systematically highlight:

– reduction of the number of cows in agricultural enterprises by 51.1% (from 624 to 424 thousand heads;

– reduction of the number of cows in households by 55% (from 2769 to 1249 thousand heads;

– increase in productivity of cows in agricultural enterprises in 2,4 times (from 2833 to 6796 kg);

– increase in productivity of cows in households by 1.3 times (from 3912 to 5120 kg);

– increase in milk supply to processing enterprises from agricultural enterprises by 1.5 times (from 1831 to 2726 thousand tons);

– reduction of almost 5 times the amount of milk received by processing enterprises from households (from 3393 to 733 thousand tons) [24]

In analytical alignment, the actual values are replaced by theoretical ones, calculated based on the function (trend equation), selected depending on the preliminary analysis of data dynamics (Figs. 1-6].

To assess the adequacy of each equation, which mathematically describes the actual trends and characterises the projected prospects, the author calculated the approximation coefficients (R^2), the value of which indicates higher accuracy and more reliable characteristics of the selected equation. According to the equations of the trend with the highest approximation coefficients, the forecast indicators of the raw material base of the dairy industry of Ukraine – milk production in agricultural enterprises and households for the period up to 2025 are determined (Table 3).

Table 3. The result of alignment by analytical functions

Indicator (factor)	Type of approximation	Forecast model	R^2
Livestock of cows			
S-g. of enterprises (Fig. 1)	Logarithmic	y=-149.9$Ln(t)$+860.37	0.9790
Households (Fig. 2)	Exponential	y=2815.8$e^{-0,048x}$	0.9824
Productivity of cows			
S-g. of enterprises (Fig. 3)	Polynomial	y=-4.3237x^2+352.3x+2266	0.9894
Households (Fig. 4)	Polynomial	y=3.8858x^2+11.126x+3946.8	0.9194
Receipts of milk to processing enterprises from:			
S-g. of enterprises (Fig. 5)	Polynomial	y=-3.7981x^2+140.92x+1443.9	0.8841
Households (Fig. 6)	Exponential	y=4362$e^{-0,1129x}$	0.9771

Source: compiled by the author.

Figures 1-6 contain visual results of equalisation by analytical functions, namely – actual, and by the established functional equations (Table 3) theoretical and forecast indicators of livestock, cow productivity and milk supply to dairy plants in Ukraine. All selected forecasting models are adequate and statistically significant, so they can be used to justify the stabilisation of the dairy industry and the prospects for the development of dairy enterprises in our country.

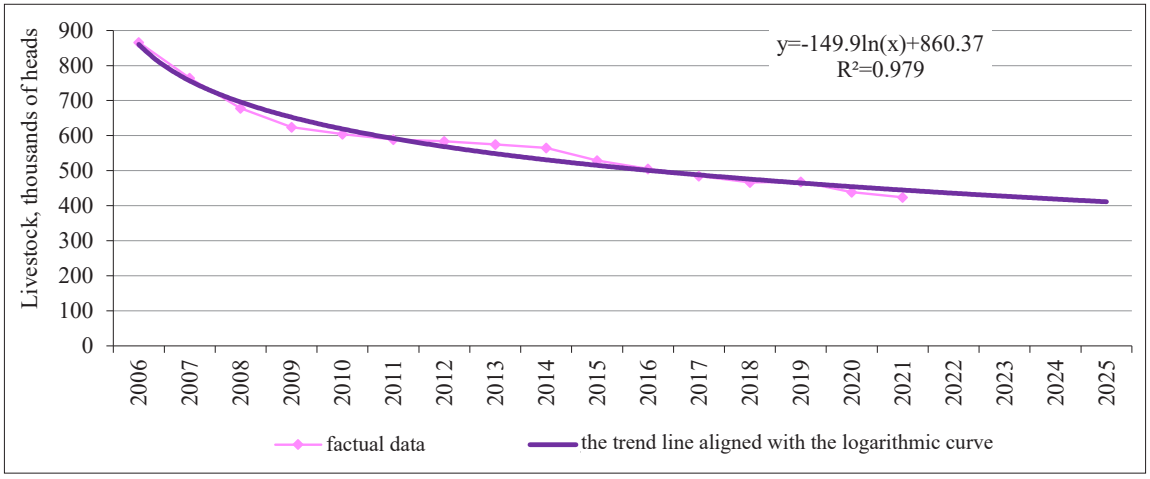

Figure 1. Dynamics of actual and forecast of theoretical livestock of cows in agricultural enterprises
Source: compiled by the author

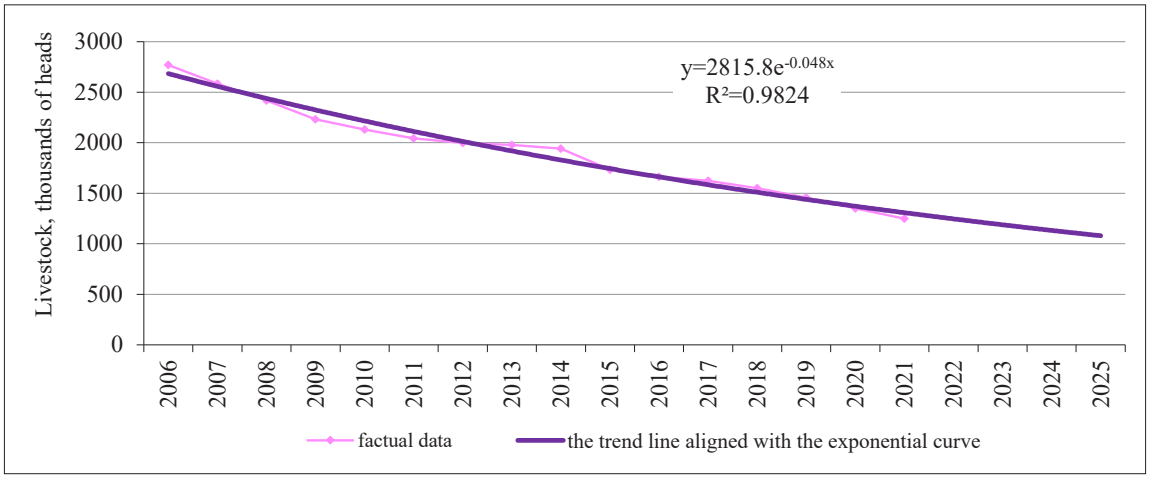

Figure 2. Dynamics of actual and forecast of theoretical livestock of cows in households
Source: compiled by the author

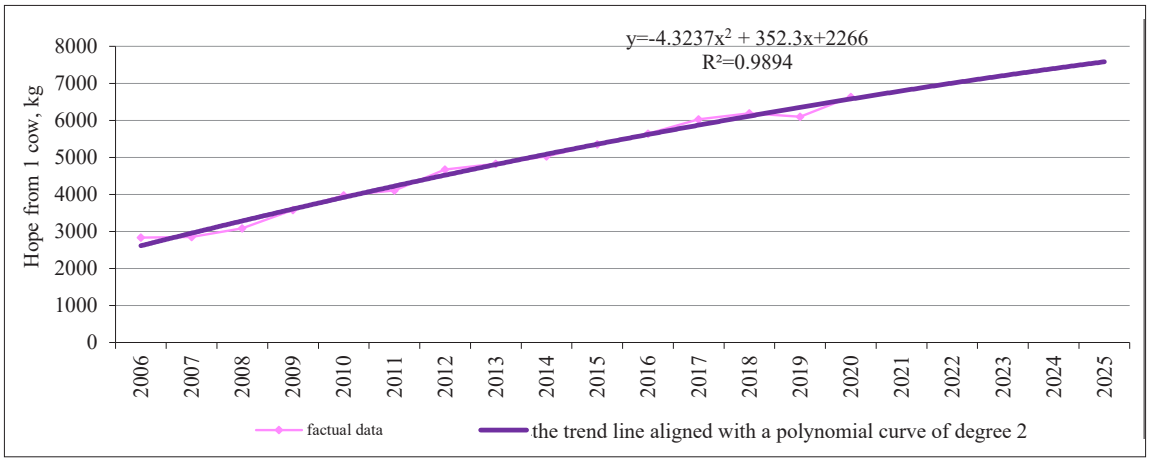

Figure 3. Dynamics of the actual and forecast of the theoretical level of productivity of cows in agricultural enterprises
Source: compiled by the author

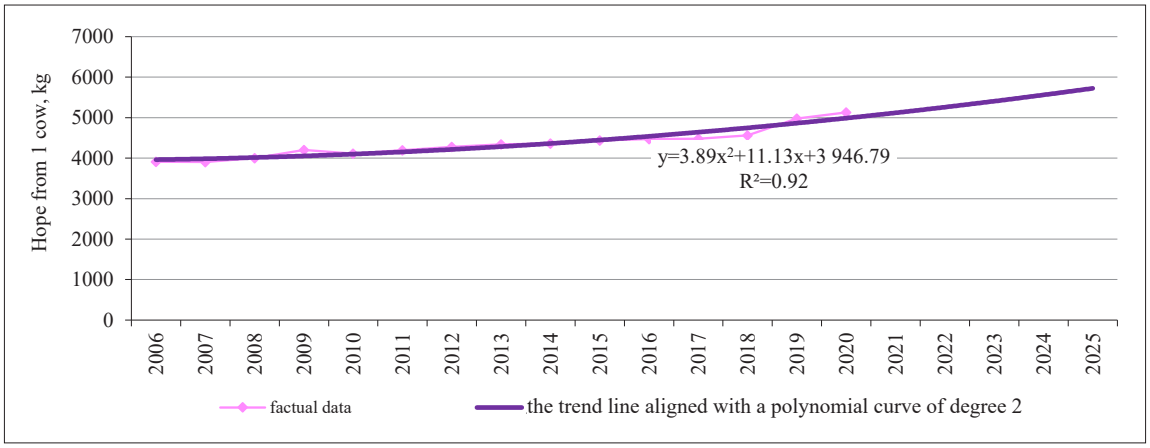

Figure 4. Dynamics of the actual and forecast of the theoretical level of productivity of cows in households
Source: compiled by the author

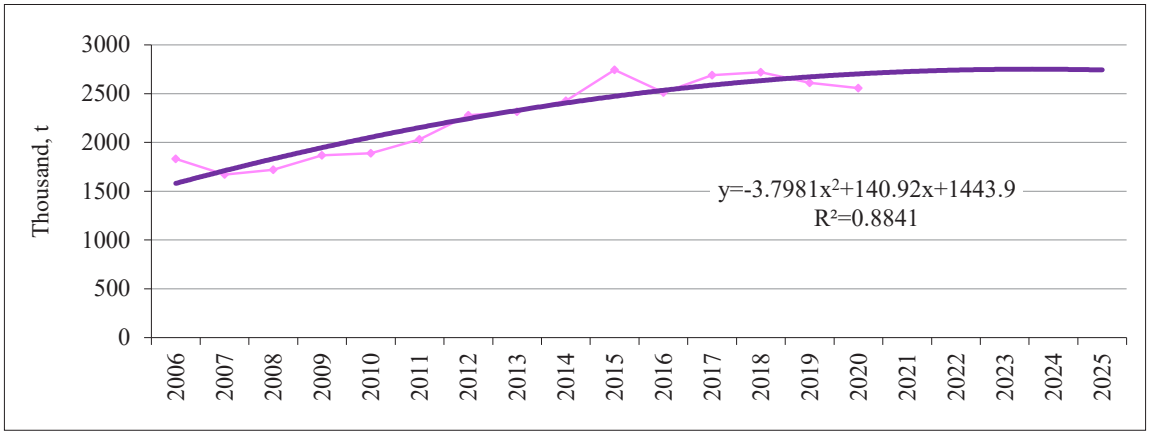

Figure 5. Dynamics of actual and forecast of theoretical milk supply to processing enterprises from agricultural enterprises
Source: compiled by the author

Figure 6. Dynamics of actual and forecast of theoretical milk supply to processing enterprises from commodity farms of the population
Source: compiled by the author

Trends identified in the forecasting process with a high degree of probability indicate a further reduction of 6.3% in livestock and an increase of 11.4% in productivity of cows in agricultural enterprises and a decrease of 21.1% in livestock and growth by 11.6% of productivity of cows in households.

At the same time, milk production in 2025 will remain at the level of 2020 and will amount to 9287 thousand tons, including 3117 thousand tons in agricultural enterprises with a growth trend of 13.0%, and in households – 6170 thousand tons while reducing its volume by 5.0%.

According to the UN, Ukraine is among the leaders in the rate of population decline in the world and is projected to decrease by 2050 to 35 million people [25]. According to the forecast of Ptoukha

Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine found that the population of the country in 2025 at medium, high and low birth rates, life expectancy and migration will be 43.7; 45.1 and 41.6 million people, respectively [26]. Given the developed two versions of the socio-demographic forecast for Ukraine using extrapolation of the trend and long-term calculations, the population in 2025 will be at 39.5 and 40.8 million people, respectively [27].

Milk production per capita will be 235 kg. With an average share of its consumption in recent years of 85% of production, the projected level of milk consumption per capita in 2025 will be 200 kg, or 51.2% of the rational norm of 390 kg. Considering the presence of the target orientation to achieve a rational level of consumption, the volume of milk production should be 18,124 thousand tons.

The supply of milk to processing enterprises from agricultural enterprises under the current trends will increase in the future from 2556 to 2743 thousand tons, or 7%. At the same time, its share in total production will decrease from 92.6 to 88.0%. The forecast of milk supply to processing enterprises from households due to its low quality indicates a negative trend of reduction from 733 to 570.6 thousand tons, or 22.2%, which will be 9.2% of the production level.

The presence of a tendency to reduce milk production in households implies the need to increase milk production by agricultural enterprises. The first scenario of achieving rational consumption of milk and products of processing enterprises involves a significant increase in production in agricultural enterprises due to a significant increase in the number of dairy herds, considering the gradual increase in its productivity.

Thus, according to estimates, by 2025 milk production should increase 4.6 times to 12,600,000 tons. Taking into account the projected level of productivity of cows in agricultural enterprises 7583 kg, the number of livestock should be increased 4 times, which in the current realities of state policy to restore dairy farming is almost unrealistic goal (Table 4).

Table 4. Forecast indicators of raw material production to ensure rational consumption of milk and dairy products

Indicators / Years	2021	2022	2023	2024	2025
Population, *million people*	41.4	40.7	40.3	39.9	39.5
Volume of milk consumption for the rational norm, thousand tons	16146	15873	15717	15561	15405
Milk production for the rational norm, *thousand tons*	18995	18674	18491	18307	18124
Scenario 1					
Required milk production, *thousand tons*	18995	18674	18491	18307	18124
including agricultural enterprises	12600	12127	12074	12018	11954
households	6395	6547	6417	6289	6170
Yield from 1 cow, kg					
All categories of farms	5176	5224	5307	5385	5449
agricultural enterprises	6796	7006	7207	7399	7583
households	5120	5259	5406	5561	5724
Livestock of cows, *thousand heads*					
All categories of farms	3103	2976	2862	2755	2654
agricultural enterprises	1854	1731	1675	1624	1576
households	1249	1245	1187	1131	1078
Scenario 2					
Livestock of cows, *thousand heads*	1697	1702	1653	1606	1563
including agricultural enterprises*	448	457	466	475	485
households	1249	1245	1187	1131	1078
Milk production, *thousand tons*					
All categories of farms	9439	9749	9776	9807	9848
including agricultural enterprises	3045	3201	3359	3518	3677
households	6395	6547	6417	6289	6170
Lack of milk consumption, *thousand tons*	9556	8925	8714	8500	8276
livestock, *thousand heads*	1406	1274	1209	1149	1091

Note: *Subject to an annual increase of 2%
Source: compiled by the author

The second scenario is based on the forecast trends in the productivity of cows in farms of all categories, including the reduction of cows in households from 1350 thousand heads in 2020 to 1078 thousand heads in 2025 with an annual increase in their number of 2% in agricultural enterprises. At the same time, the annual shortage of rational consumption of milk and dairy products will range from 9.6 million tons in 2021 to 8.3 million tons in 2025. The shortage of livestock will tend to decrease from 1406 thousand heads in 2021 to 1091 thousand heads in 2025.

According to the forecasted indicators of the

constructed trends of development of the raw material base of the Ukrainian dairy industry, it is expedient to provide and substantiate perspective tendencies of volumes and assortment structure of dairy production by processing enterprises of Ukraine.

It is estimated that the volume of production of such dairy products as butter in 2025 will not change significantly and will remain at the level of 2020. The increase in production is projected for the following types of products: yogurt, kefir, sour cream – by 37.6%, from 441.2 to 607.2 thousand tons; sour milk cheese and baby food products – by 36.3%, from 7.6 to 10.3 thousand tons, condensed milk and cream – by 30.1%, from 37.8 to 49.1 thousand tons, milk and cream with a fat content of more than 6% – by 19.7%, from 60.8 to 72.8 thousand tons; milk for baby food – by 18.3%, from 17.3 to 20.4 thousand tons; processed liquid milk – by 11.5%, from 105.3 to 117.2 thousand tons.

Relatively insignificant decrease in production of hard cheeses – by 7.8%, or 6.7 thousand tons, milk powder and cream – by 10.6%, which is 4.9 thousand tons, fresh unfermented cheese – by 11.2%, or 8.3 thousand tons, and fermented milk products for baby food – by 22.2%, or 0.9 thousand tons (Table 5).

Table 5. Dynamics of forecast parameters of dairy production in Ukraine, tons

Indicators	Fact 2020	Type of approximation	Forecast model	R^2	2021	2022	2023	2024	2025	2025 to 2020, %
Processed liquid milk	1053117	Polynomial	$y=1596.3x^2-6302.2x+947267$	0.4489	1043875	1071095	1101508	1135113	1171911	99.1
Milk (and cream) for baby food is condensed and sugar-free	17258	Stagnant	$y=10540x^{0.3022}$	0.7687	20102	20215	20257	20360	20414	118.3
Milk and cream with a fat content of more than 6%	60843	Stagnant	$y=39687x^{0.2304}$	0.6389	66540	68325	70843	71220	72839	119.7
Milk and cream dry	45668	Exponential	$y=68457e^{-0.04x}$	0.7947	46722	45582	44742	43638	40810	89.4
Butter	87455	Polynomial of the 3rd degree	$y=66.297x^3-1875\ x^2+13998\ x+76076$	0.5602	94813	91372	88556	86762	86389	98.8
Fresh unfermented cheese	73782	Logarithmic	$y=-5630Ln(t)+80367$	0.4778	67403	66867	66377	65926	65509	88.8
Sour milk cheese and baby food products	7576	Linear	$y=520.25x+3039.1$	0.8287	8241.6	8761.85	9282.1	9802.35	10322.6	136.3
Rennet cheeses	85230	Stagnant	$y=147208x-0.2592$	0.8556	84045	81348	80674	79325	78541	92.2
Cream cheese	30621	Polynomial	$y=-42{,}937x^2+1503.2x+20251$	0.9712	30989	31591	32106	32536	32880	107.4
Milk and cream, condensed or with added sugar	37765	Polynomial	$y=471.86x^2-8293.8x+72748$	0.9641	36996	38611	41170	44673	49119	130.1
Yogurt, kefir, sour cream	441205	Polynomial	$y=3652x^2-48010x+563532$	0.7717	448632	477314	513300	556590	607184	137.6
Fermented milk products for baby food	4006	Exponential	$y=6631{,}3e^{-0.0539x}$	0.6799	3868	3665	3473	3291	3118	77.8

Source: compiled by the author

Achieving stable and relatively progressive trends in the development of the Ukrainian dairy industry is possible in the case of increasing innovation activity of dairy enterprises. For example, Lustdorf uses innovative high-temperature pulse (UHT) technology in dairy production. Its essence is that for only 2-4 seconds the raw milk is subjected to a heat pulse at a temperature of 137°C, after which

it cools down to 25°C just as quickly. This advanced technology makes it possible to destroy all pathogenic bacteria and at the same time preserve the natural value of milk – protein, vitamins, trace elements [28].

Thanks to careful heat treatment, ultra-pasteurised dairy products can be stored in a closed package for up to six months. Another innovation used by Lustdorf in the preparation of raw materials for production is steam treatment. The technology assumes that steam is injected into raw milk under high pressure (4 bar), which instantly heats it to 140°C, and after a few seconds the milk is cooled to 20°C without contact with air and light. This gently cleanses the milk from foreign bacteria, while preserving its benefits and delicate pleasant taste without the taste of boiling [28].

Dairy enterprises of the Dairy Alliance group of companies have been gradually carrying out radical reconstruction and modernisation of production facilities in recent years. New shops for packing pasteurised milk and whole milk products are put into operation, cheese-making shops are equipped with modern equipment, where the production process is fully automated. Particular attention is paid to input control of raw materials, control over the technological process and output control of finished products. By equipping all reception points with new technological equipment for cooling and storage of milk, companies have managed to improve the qualitative and quantitative characteristics of raw materials for processing [29].

At the same time, the development of any enterprise has clearly defined specific features of implementation, which are mediated by the economic mechanism of increasing their economic efficiency. Each individual milk processing enterprise has an individual staffing and ratio of elements of resource potential that directly affect the competitiveness of enterprises and the pace of their development. Therefore, the development of a strategy to increase the level of innovation activity of the enterprise is aimed not only at maintaining its existing market position, but also by increasing the existing competitive advantage with the justification of a scientific approach to this phenomenon and process. The priority target guidelines of the strategy for intensifying the innovative activity of dairy enterprises are the following:

– development, substantiation and implementation in practice of measures to stabilise, expand and ensure the high quality of the Ukrainian raw material base and the creation of new raw material zones of the dairy industry;

– intensification of processes of wide introduction of innovations at the enterprises of agricultural milk producers for increase of production volumes;

– ensuring conditions of the most uniform, especially during the season, loading of production capacities of dairy processing enterprises;

– substantiation and effective implementation of the state policy on milk market regulation and investment support of the strategy of intensification of innovative activity not only of milk processing enterprises, but also of economic entities that form the raw material base of the dairy industry.

Intensification of innovative activity of enterprises in the industry will help increase productivity, quality of raw milk and a range of dairy products; efficiency of dairy farming and increasing the level of provision of dairy processing enterprises with quality raw materials; optimisation of purchasing price policy for milk; growth of production and supply of extra milk to processing enterprises; increasing the profitability of dairy enterprises.

At the same time, organisational and managerial innovations can become an important source of other types of innovative changes and growth of innovation activity, as the decision on the need for innovative transformations is made at the managerial level. The development of measures to increase the level of innovation activity of dairy enterprises requires a comprehensive analysis of all parts of the relationship between the participants of the system "milk production → milk processing → dairy sales" and their infrastructure links, which significantly affect the effectiveness of this marketing chain.

The essence of developing the concept of increasing the level of innovation activity of economic entities is to determine the innovation goal that can be achieved by a particular enterprise in view of its market position, innovation and resource capabilities. Based on the innovation goal the innovation strategy of the enterprise is formed, which should envisage combining the goals of technical and investment policy and be aimed at the introduction of new technologies and types of products, services and their promotion on the market. Thus, innovation is a leading link in strategic development management to achieve future market results to increase the competitiveness of dairy enterprises.

The key to the effectiveness of increasing the level of innovation activity of dairy enterprises should be the maximum reduction in the development of measures for the implementation of technical, technological and product innovations. Successful implementation of these tasks should be ensured by established, formalised and standardised measures for the development and implementation of strategies for innovation and production activities, which systematically cover the operating environment of the entity. These include its available resource-production and market potential, the results of monitoring of specific innovative developments and products that are implemented or can potentially be implemented in the enterprise in production, forecast parameters of future performance.

To justify the best expected result from the implementation of measures to increase the level of innovation activity of enterprises develop alternative solutions to problems, the tools of which include:

– modernisation of enterprises to increase their competitiveness;

– updating the traditional range of products;

– production of innovative products;

– introduction of innovative methods in operational activities, personnel development, marketing and logistics, aimed at maximizing customer satisfaction and profit (Fig. 7).

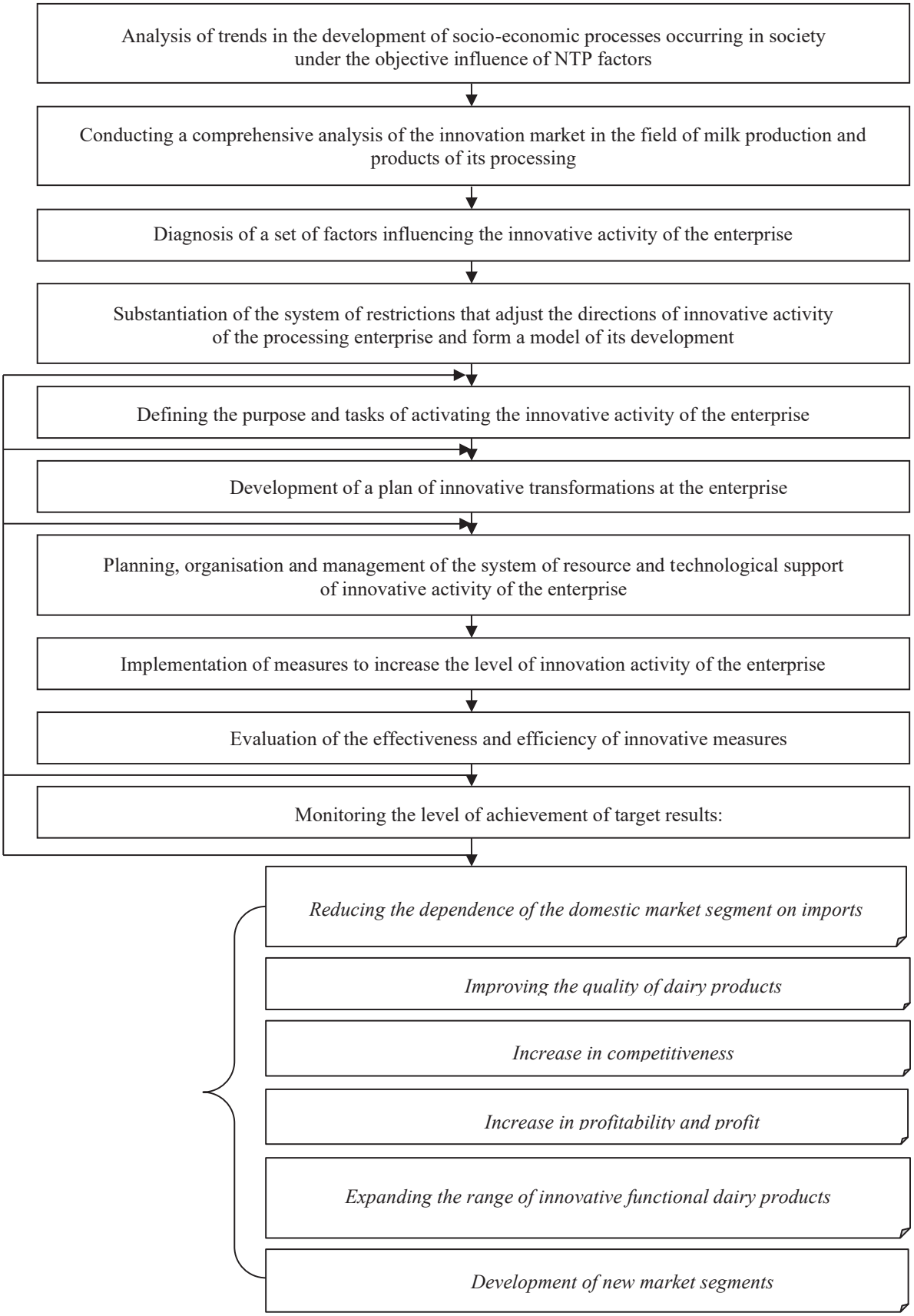

Figure 7. Algorithm for increasing the innovative activity of the processing plant
Source: compiled by the author

Conclusions

The vector of progressive development of the dairy industry focuses on the sequence of organisational and technological chain and adaptive system of innovative support for dairy production, based on the results of research teams in the raw materials and processing industries.

Innovative tools for the development of dairy enterprises include priority areas for improving the selection of raw materials for in-depth processing, production of special types of dairy products with high biological and nutritional value and guaranteed quality and safety of energy-saving equipment of reduced metal content, higher productivity and production efficiency.

Systematic formation and strategic purposefulness of interrelated scientific developments and practical achievements provide innovative development of raw materials and milk processing and have a comprehensive impact on the press to stabilize and further develop the dairy industry and can create a positive synergistic effect.

Prospects for the development of the raw material base of the dairy industry on the basis of time series and a forecast built by 2025 on mathematically established patterns of its operation for the period 2016-2021 indicate a reduction in livestock and productivity of cows and milk production in 2025 at 2020 9287 thousand tons. The supply of milk to milk processing enterprises will amount to 3314 thousand tons, or 37.5% of agricultural production.

The level of consumption of milk and milk products in terms of milk per capita in 2025 will be 200 kg, or 51.2% of the rational norm of 390 kg, to achieve which milk production should increase to 18,124 thousand tons. According to the perspective trends of volumes and assortment structure of dairy products of processing enterprises, the production of butter in 2025 will remain at the level of 2020 with the increase of some of its sour milk types for baby food, milk and condensed cream.

Increasing the level of innovation activity of dairy enterprises is based on the relationship between participants in the marketing chain of production and processing of milk and dairy products, their infrastructure links and resource capabilities, organisational and managerial measures for technical, technological and product innovations and alternative solutions to problems.

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Перспективи підвищення рівня інноваційної активності молокопереробних підприємств

Світлана Георгіївна Черемісіна[1], Володимир Васильович Россоха[2], Михайло Вікторович Кривун[3]

[1]Національний науковий центр «Інститут аграрної економіки»
03127, вул. Героїв Оборони, 10, м. Київ, Україна

[2]Національний університет «Києво-Могилянська академія»
04070, вул. Г. Сковороди, 2, м. Київ, Україна

[3]Національний університет харчових технологій
01033, вул. Володимирська, 68, м. Київ, Україна

► **Анотація.** Прогресивний розвиток молочної галузі потребує удосконалення технологій кормовиробництва, утримання, годівлі, нарощення поголів'я тварин, ведення селекційно-племінної роботи в господарствах, підвищення генетичного потенціалу порід, доїння корів, зберігання й переробки молока та виробництва необхідного для населення асортименту молокопродукції. Успішна реалізація цих технологічних процесів потребує дієвої системи інноваційного забезпечення молочного виробництва, важливе значення для якого мають наукові розробки установ Національної академії аграрних наук України. Водночас здатність молокопереробних підприємств до інноваційного розвитку визначається трансформаціями їх господарського механізму шляхом впровадження технічних, організаційних та управлінських досягнень у сфері технологій. Мета статті – дослідження сучасних реалій, можливостей та прогнозування основних вимірів щодо активізації інноваційної діяльності молокопереробних підприємств України. У процесі дослідження використано низку методів: монографічний; порівняльний аналіз; прогнозування; табличний; розрахунково-конструктивний; графічний, абстрактно-логічний. Встановлено наявність адаптованої системи інноваційного забезпечення та систематизовано наукові розробки контролю при відборі молочної сировини, вітамінної натуралізації молока, технологій виробництва дієтичних молочних продуктів, автоматизації виробничих процесів, теплової обробки молока з використанням сучасних матеріалів упаковки для продовження терміну його зберігання, впровадження інноваційних методів в операційну діяльність, розвиток персоналу, маркетинг і логістику, використання яких доцільно поширювати у системі господарського механізму функціонування і розвитку молочної галузі. Визначено прогнозні показники сировинної бази молочної галузі України, яка у 2025 році залишиться на рівні 2020 року і становитиме 9287 тис. тонн, при зростанні обсягів виробництва молока у сільськогосподарських підприємствах на 13,0 % і зниженні і в господарствах населення на 5,0 %. Встановлено необхідні обсяги виробництва сировини для забезпечення виробничих потужностей молокопереробних підприємств і раціональної норми споживання молока та молокопродуктів. Побудовано динаміку прогнозних показників виробництва молочної продукції в Україні. Обґрунтовано пріоритетні цільові настанови стратегії активізації інноваційної активності молокопереробних підприємств. Запропоновано алгоритм підвищення інноваційної активності переробного підприємства. Вказані підходи та результати дослідження можуть бути використані органами державного і галузевого управління під час організації моніторингу та розробки пріоритетних заходів щодо активізації інноваційної діяльності підприємств української молочної галузі

► **Ключові слова:** молоко, молочна продукція, інновації, виробництво, переробка