IRSTI 68.39.31
UDC 338.43:636.2 https://www.jpra-kazniiapk.kz
Research Article https://doi.org/10.46666/2026-2.2708-9991.21

DAIRY CATTLE FARMING IN THE NORTHERN REGION OF THE REPUBLIC OF KAZAKHSTAN: ACCOUNTING AND ANALYTICAL CRITERIA

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ СОЛТҮСТІК ӨҢІРІНДЕГІ СҮТТІ МАЛ ШАРУАШЫЛЫҒЫ: ЕСЕПКЕ АЛУ-ТАЛДАУ КРИТЕРИЙЛЕРІ

МОЛОЧНОЕ СКОТОВОДСТВО В СЕВЕРНОМ РЕГИОНЕ РЕСПУБЛИКИ КАЗАХСТАН: УЧЕТНО-АНАЛИТИЧЕСКИЕ КРИТЕРИИ

L. BEKBOSSYNOVA*
Ph.D student
S. Seifullin Kazakh Agro Technical Research University, Astana, Kazakhstan
**corresponding author's email: l.bekbossynova@kazatu.edu.kz*
Л.Ж. БЕКБОСЫНОВА*
Ph.D докторанты
С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Қазақстан
**автордың электрондық поштасы: l.bekbossynova@kazatu.edu.kz*
Л.Ж. БЕКБОСЫНОВА*
докторант Ph.D
Казахский агротехнический исследовательский университет им. С. Сейфуллина, Астана, Казахстан
**электронная почта автора: l.bekbossynova@kazatu.edu.kz*

Abstract. *The objective* – is to substantiate a strategic accounting and analytical model for the sustainable development of dairy cattle farming based on the management of cattle productivity. *Methods* – an economic and statistical analysis was conducted to assess the dynamics of sectoral indicators (livestock numbers, gross milk production, and production costs) for 2024–2025; factor and structural analyses were employed to identify the impact of productive performance on cost levels and to detect structural imbalances; economic and empirical modeling was applied to formalize the relationship between «costs – performance – maintenance costs»; and an analytical survey of agricultural enterprises, based on a stratified sample of 74 farms, was conducted to examine the extent of digitalization and the application of management accounting practices. In addition, methods of comparison, grouping, and data generalization were used to compare business entities according to herd size, identify differences in the degree of digital technology adoption and livestock productivity, and systematize the factors affecting production efficiency. The scientific novelty of the study lies in the integration of biological and economic parameters within the accounting system, where economic return is regarded as the key criterion for cost assessment. *Results* – the study demonstrates that a 28.6% decline in milk yield was accompanied by a 92% increase in cost indicators, while total expenditures increased by only 11.7%, confirming the biological and economic nature of the crisis phenomena. *Conclusions* – the gap between cost control and production performance demonstrates the necessity of implementing an integrated model and a digital accounting and analytical system. Achieving these objectives requires the wider adoption of digital tools, the improvement of expenditure tracking and analytical systems, the optimization of resource utilization, and the alignment of management decisions with productivity indicators under changing external conditions. The integration of information on feeding rations, livestock health status, and environmental parameters simplifies herd management and streamlines accounting procedures.

Аңдатпа. *Мақсаты* - ІҚМ өнімділігін басқару негізінде сүтті мал шаруашылығын тұрақты дамытудың стратегиялық есепке алу-талдау моделін негіздеу. *Әдістері* - 2024-2025 жылдардағы салалық көрсеткіштердің (мал басы, сүттің жалпы өндірісі, өзіндік құны) динамикасын бағалау үшін экономикалық-статистикалық зерттеу, өнімді белсенділіктің шығындар деңгейіне әсерін анықтау және диспропорцияларды анықтау үшін пайдаланылған факторлық және құрылымдық талдау, "шығыстар-нәтижелілік-ұстау құны" тәуелділігін ресімдеуге мүмкіндік берген экономикалық-эмпирикалық модельдеу, цифрландыру ауқымын және басқарушылық есепке алу практикасын зерделеу мақсатында стратификацияланған іріктеме (74 шаруашылық)

негізінде жүргізілген ауыл шаруашылығы кәсіпорындарын талдамалық зерттеу. Шаруашылық жүргізуші субъектілерді табын мөлшері бойынша теңестіру кезінде деректерді салыстыру, топтастыру және жалпылау, цифрлық технологиялар мен жануарлардың өнімділігі дәрежесінің айырмашылықтарын анықтау, өндірістік процестердің тиімділік факторларын жүйелеу әдістері қосымша ұсынылған. Ғылыми жаңалық-биологиялық және экономикалық параметрлерді бухгалтерлік есеп жүйесінде интеграциялау, мұнда экономикалық қайтарым шығындардың негізгі критерийі ретінде қарастырылады. *Нәтижелер* - сүттің 28,6%-ға төмендеуі жиынтық шығыс бөлігінің тек 11,7% - ға ұлғаюымен құн индикаторларының 92% - ға өсуімен қатар жүретіні көрсетілген, бұл дағдарыс құбылыстарының биологиялық-экономикалық сипатын растайды. *Қорытындылар* – шығындар базасын бақылау мен өндірістік параметрлер арасындағы алшақтық интеграцияланған модель мен цифрлық есеп-аналитикалық жүйені енгізу қажеттілігін дәлелдейді. Аталған мақсаттарға қол жеткізу цифрлық құралдарды қолдануды кеңейтуді, шығыстарды қадағалау және талдау жүйелерін жетілдіруді, ресурстарды пайдалануды оңтайландыруды, сондай-ақ өзгермелі сыртқы орта жағдайында басқару шешімдерін өнімділік көрсеткіштерімен үйлестіруді талап етеді. Рацион, малдың жағдайы, қоршаған орта параметрлері туралы ақпаратты біріктіру табынды басқару процесін жеңілдетеді, есептік операцияларды ұйымдастырады.

Аннотация. *Цель* - обоснование стратегической учетно-аналитической модели устойчивого развития молочного скотоводства на основе управления продуктивностью КРС. *Методы* – экономико-статистическое исследование для оценки динамики отраслевых показателей (поголовье, валовое производство молока, себестоимость) за 2024–2025 гг., факторный и структурный анализ, использованные для выявления влияния продуктивной активности на уровень затрат и обнаружения диспропорций, экономико-эмпирическое моделирование, позволившее формализовать зависимость «расходы – результативность – стоимость содержания», аналитическое обследование сельскохозяйственных предприятий, проведенное на основе стратифицированной выборки (74 хозяйства), с целью изучения масштаба цифровизации и практик управленческого учета. Дополнительно представлены методы сравнения, группировки и обобщения данных при сопоставлении хозяйствующих субъектов по размеру стада, определения различий степени цифровых технологий и производительности животных, систематизации факторов эффективности производственных процессов. Научная новизна заключается в интеграции биологических и экономических параметров в системе учетности, где экономическая отдача рассматривается как ключевой критерий издержек. *Результаты* - показано, что снижение удоев на 28,6% сопровождалось ростом стоимостных индикаторов на 92% при увеличении совокупной расходной части лишь на 11,7%, что подтверждает биолого-экономическую природу кризисных явлений. *Выводы* – разрыв между контролем затратной базы и производственными параметрами доказывает необходимость внедрения интегрированной модели и цифровой учетно-аналитической системы. Достижение указанных целей требует расширения применения цифровых инструментов, совершенствования систем отслеживания расходов и анализа, оптимизации использования ресурсов, а также согласования управленческих решений с показателями продуктивности в условиях изменяющейся внешней среды. Интеграция информации о рационе, состоянии поголовья, параметров окружающей среды упрощает процесс управления стадом, упорядочивает расчетные операции.

Keywords: dairy cattle farming, cattle, management accounting, zootechnical control, productivity, milk yield, costs, production cost.

Түйінді сөздер: сүтті мал шаруашылығы, ірі қара мал, басқару есебі, зоотехникалық бақылау, өнімділік, сүт сауу, шығындар, өзіндік құн.

Ключевые слова: молочное скотоводство, крупный рогатый скот, управленческий учет, зоотехнический контроль, продуктивность, надой молока, затраты, себестоимость.

Received: 14.04.2026. Approved after Peer-reviewed: 06.06.2026. Accepted: 15.06.2026.

Introduction

Dairy farming constitutes a pivotal segment of the agro-industrial complex, thereby ensuring food security and employment for the rural population. However, recent years have seen a decline in herd productivity and an increase in production costs, indicating structural imbalances in the industry. The economic and biological nature of dairy production implies that economic results are shaped by biological outcomes, including cow productivity, which is interrelated with feed rations, housing conditions, and veterinary care (Steeneveld W., van den Borne B.H.P., Kok A. et al.; Tschopp R., Gemechu G., James L.N.) [1, 2]. Research indicates that diminished productivity engenders

elevated production costs, provided that these costs are not accompanied by an augmentation in milk yield International Financial Corporation (IFC) (Management's Discussion and Analysis …) [3].

Concurrently, digital technologies are emerging as a pivotal instrument for enhancing agricultural efficiency. Systematic reviews demonstrate that digital analytics, encompassing Business Intelligence (BI) systems and data integration, are associated with enhanced productivity and diminished costs (Porciello J., Coggins S., Mabaya E. et al.; Manzoor F., Longdao W., Mahwish S.) [4,5]. However, in transition economies, including Kazakhstan, the implementation of digital solutions remains limited due to fragmented data and the lack of integrated accounting systems (Chamorro-Padial J., García R., Gil R.) [6].

Concurrently, the field of management accounting has historically concentrated on retrospective cost control, with an inadequate link to biological indicators. Contemporary notions of strategic accounting underscore the necessity of integrating financial and non-financial Key Performance Indicators (KPIs) to inform long-term decision-making. In this regard, it is imperative to construct a strategic accounting and analytical model that integrates costs, productivity, and production costs, as well as assesses the impact of the digitalization of management procedures on the sustainability of dairy farming.

Literature review

Dairy farming, as an integral component of the agro-industrial complex, is distinguished by its intricate biological and economic characteristics. The outcomes of economic endeavors in this sector are influenced not solely by economic factors but also by biological considerations. The quality of feeding, the feed base, and animal health have a direct impact on herd productivity and the cost of milk. This impact has been confirmed by research in modern zootechnical and economic sciences (Umbitaliev A.D., Toyaova G.Zh., Kulanova D.A.) [7].

According to the findings of the international literature on the subject, there is a strong correlation between animal diseases and reproductive inefficiency, on the one hand, and significant economic losses, on the other. Furthermore, these diseases have a multiplicative effect on herd productivity and farm sustainability. (Joao H.C., Melissa C., Heather W.) [8]. An analysis of the extant literature on digitalization further demonstrates the growing importance of precision farming technologies and digital platforms for improving the efficiency of agricultural enterprise management (Konuspaev R.K., Baigarina A.T., Taipov T.A.) [9].

Research on digital agriculture indicates that the introduction of digital solutions – including sensor systems, IoT devices, big data analytics platforms, and automation - can increase productivity and sustainability by enabling more precise control over feeding parameters, herd health, and resource efficiency (Peña-Holguín R.R., Vaca-Coronel C.A., Farías-Lema R.M. et al.; Manzoor F., Wei L., Siraj M. et al.) [10, 11]. Digital technologies have been shown to have a particularly positive effect on productivity, largely due to their ability to enhance the quality of monitoring and management of farming operations.

Concurrently, global reviews indicate that the majority of studies on digitalization in agriculture concentrate on the implementation of digital advisory and agronomic services. However, these studies do not adequately examine the relationship between digital data and economic outcomes within specific production systems (Coggins S., Mabaya E., Otunba-Payne G.) [12]. This phenomenon can be attributed to the disparate development of digital infrastructure within the agricultural sector, particularly in regions characterized by a preponderance of small and medium-sized farms.

As evidenced by regional publications from Kazakhstan, the agricultural sector has undergone significant structural transformations. Academic reviews have identified the necessity to modernize the dairy sector, enhance technological innovation, strengthen strategic management accounting, and cultivate a digital analytical environment (Nasyrakhanova B.E., Belgibaeva A.S.; Belgibaeva A.S.) [13, 14]. These conclusions align with the international concepts of strategic management accounting, which emphasize the integration of financial and non-financial management indicators (International Farm Comparison Network…; International Federation of Accountants…) [15,16].

Conceptual approaches to strategic management accounting underscore the significance of incorporating production indicators (e.g., productivity, feed base status) into management decision-making systems, a consideration that assumes particular relevance for industries characterized by protracted biological cycles, such as dairy farming (Kaplan R.S., Norton D.P.) [17]. This transition necessitates a shift from cost accounting to management factor analytics, a transformation that has yet to be adequately reflected in the practices of Kazakhstani farms.

Consequently, within the domain of scientific literature, the sustainability of dairy farming

is linked to a multifaceted nexus of biological, structural-economic, and information-analytical factors. The integration of cost accounting and productivity indicators is inadequate, and the digitalization of management processes is insufficient. These factors are considered to be the primary constraints on the sustainable development of the industry at the regional level.

Materials and methods

The empirical basis for the study was provided by official statistical data from the Bureau of National Statistics of the Agency for Strategic Planning on cattle numbers and gross milk production over the years, as well as materials from a survey of dairy farms in the Akmola region conducted in 2024–2025. The sample included 74 farms, which met the requirements for representativeness with a total population of approximately 300–320 economically active dairy farms in the region and a margin of error of 10%.

The selection was executed through the implementation of a stratified sampling method, which was predicated on herd size (up to 50, 50–100, 100–500, over 500 head). This methodological approach was employed to ensure the preservation of the industry structure and the comparability of results.

The study employed a range of analytical methods, including economic and statistical analysis, index comparison, structural and dynamic analysis, as well as factor analysis. These analyses were used to examine the impact of productivity on the cost of milk. In order to assess the biological and economic relationship, a calculation model was utilized. This model, which was based on the breakdown of total costs into feed, labor, veterinary, energy, and depreciation components, was called "costs → milk yield → cost price".

The degree of digitalization of farms was evaluated through a questionnaire comprising nine indicators, encompassing the utilization of accounting systems, zootechnical programs, automated milking systems, digital feeding records, and analytical tools. The data obtained was processed using descriptive statistics and comparative analysis by farm group. This facilitated the identification of the impact of structural and information factors on the economic sustainability of dairy farming in the region.

Results

In order to ensure the representativeness of the empirical study, the sample of agricultural enterprises was formed using a stratified selection method. This method involves dividing the general population into homogeneous groups (strata) according to an economically significant criterion, such as the size of the cattle herd. This approach is predicated on the notion that the scale of production determines the technological level of the farm, the cost structure, access to investment resources, and, consequently, the degree of digital technology adoption and the level of management accounting. Consequently, herd size emerges not only as a production factor but also a management factor, as illustrated in table 1.

Table 1 - Correspondence between the sample structure and the regional herd structure

Group of farms	Share in the region, %	Number of farms in the sample	Share in the sample, %
up to 50 heads	45	33	44.6
50–100	25	18	24.3
100–500	20	15	20.3
>500	10	8	10.8
Total	100	74	100
Note: compiled by the author based on the results of a survey of agricultural enterprises in the Akmola region (2024–2025)			

The deviations between the shares in the region and the sample do not exceed ±1%, which confirms the correctness of the stratification and the preservation of the structural proportions of the industry.

The sample size was 74 farms, which corresponds to the estimated minimum for the general population of economically active dairy farms in the region (N≈310) with a margin of error of 10%. Questionnaire structure and survey results, table 2.

The results of a survey of dairy farms in the Akmola region indicate that the digitization of management processes is unsystematic and functionally limited. The implementation of digital solutions is predominantly concentrated in the domain of regulated financial accounting. It is noteworthy that 71.6% of farms utilize accounting programs such as 1C, though these systems are predominantly designed for reporting and tax accounting purposes, rather than for analyzing production efficiency factors. Consequently, the focus of digital transformation initiatives is on the implementation of digital technologies in accounting processes rather than on the analysis and integration of data.

Table 2 – Results of a survey of dairy farms in the Akmola region (2024–2025)

Questionnaire question	Response type	Number of "Yes" answers	Share, %
Is accounting software (1C, Parus, etc.) used?	Yes/No	53	71.6
Is management accounting done in Excel?	Yes/No	45	60.8
Is specialized zootechnical accounting software used (milk yield, reproduction)?	Yes/No	18	24.3
Is there an electronic database of animals (identification, productivity history)?	Yes/No	14	18.9
Are automatic milking machines with digital milk yield recording used?	Yes/No	8	10.8
Is digital feeding and ration accounting used?	Yes/No	5	6.8
Is there integration between accounting and zootechnical data?	Yes/No	9	12.2
Are BI dashboards used to analyze indicators?	Yes/No	3	4.1
Are predictive calculations (scenario modeling) performed?	Yes/No	2	2.7
Note: developed by the author based on empirical survey data collected from dairy farms			

Manual data processing continues to play a significant role in management practice; 60.8% of farms use spreadsheets (Excel) as their primary calculation tool. This phenomenon is indicative of a paucity of automated information processing algorithms, an augmented probability of errors, and an incapacity to undertake periodic factor analysis of cost and productivity. Consequently, management decisions are predominantly informed by post-factum calculations, thereby impeding the agility of responses to fluctuations in production parameters.

Of particular significance is the insufficient level of digitization of biological data. A mere 24.3% of farms utilize specialized zootechnical programs that facilitate digital recording of productivity, reproduction, and herd status. In other cases, milk yield is recorded but not analyzed in terms of dynamics. Furthermore, there is no link between feeding and productivity indicators, which makes it impossible to calculate feed conversion and evaluate the effectiveness of diets. Consequently, the pivotal biological factor that governs the cost of milk remains beyond the purview of systematic analytical processing.

Additionally, production automation levels are suboptimal, with automatic milking machines equipped with digital milk yield recording utilized on only 10.8% of farms and digital feeding control systems employed on a mere 6.8% of farms. Consequently, the primary determinants of productivity – namely, the milking regime, feeding ration, and the physiological condition of the animals – are managed without digital support, thereby limiting the possibilities for accurate control and optimization of production processes.

In conclusion, the lowest indicators are indicative of strategic-level analytical technologies. Furthermore, the utilization of BI panels remains limited, with only 4.1% of farms employing them. Similarly, the adoption of predictive calculations and scenario modeling is even less prevalent, with only 2.7% of farms implementing these practices. This finding suggests a deficiency in the availability of tools to integrate financial and production data, to monitor key performance indicators (KPIs), and to assess the long-term ramifications of management decisions. Consequently, the primary function of management accounting is recording-based, which does not facilitate the provision of strategic analytics essential for the sustainable development of the industry.

The identified structure of digitalization confirms that the information environment of dairy farming in the region is focused on recording past operations, while tools for analyzing productivity, optimizing feeding, and strategic forecasting are practically not used. This discrepancy engenders an informational lacuna between production processes and management decisions, thereby impeding the efficiency of dairy production.

The economic and statistical analysis and survey results demonstrated that the primary issue in dairy farming in the region is not solely resource constraints, but also the absence of a systematic management of herd productivity as a pivotal economic factor. The majority of farms maintain records of costs and milk yields independently; however, there is an absence of an analytical correlation between these indicators. This discrepancy gives rise to a rift between accounting and management.

Dairy production is characterized by two distinct yet interconnected facets: biological and economic. The determination of output is contingent upon the following factors:

$$Q=Y\times N \quad (1)$$

Where, Y is the average annual milk yield per cow (KPIs), N is the number of cows.

Cost per unit of production:

$$C = \frac{Z}{Y \times N} \quad (2)$$

Consequently, productivity is a cost multiplier. When productivity declines, semi-fixed costs are distributed over a smaller volume of output, causing a disproportionate increase in production costs, table 3.

Table 3 - KPI productivity and economic indicators of dairy production in the Akmola region

Indicator	2024	2025	Relative change
Gross milk yield, thousand tons	404.6	234.8	– 41.9%
Cow population, thousand heads	455.0	370.0	– 18.7%
Average milk yield per cow, kg (KPI)	889.0	635.0	– 28.6%
Total costs, billion tenge	150.4	168.0	+11.7%
Cost of 1 kg of milk, tenge	372.0	716.0	+ 92%
Note: the indicators of herd size, milk production, productivity, and cost were calculated by aggregating data from the surveyed farms and extrapolating the results to the population of economically active dairy farms in the Akmola region.			

A 28.6% decrease in milk yield was accompanied by a 92% increase in production costs, with a moderate increase in expenses. This finding lends further credence to the hypothesis that:

The following assertions have been made:

- productivity is the primary factor in economic stability;
- a decrease in feed efficiency leads to an economic crisis more rapidly than an increase in expenses;
- cost management without productivity KPI management does not ensure efficiency.

Consequently, milk yield serves as a pivotal metric for evaluating the influence of feeding practices, veterinary care, and technological advancements in husbandry. However, survey data indicates that only 24.3% of farms maintain digital zootechnical records, and only 12.2% of farms integrate production and financial data. Consequently, productivity key performance indicators have not been incorporated into the management analytics system. A subsequent stratified analysis revealed a structural dependence, table 4.

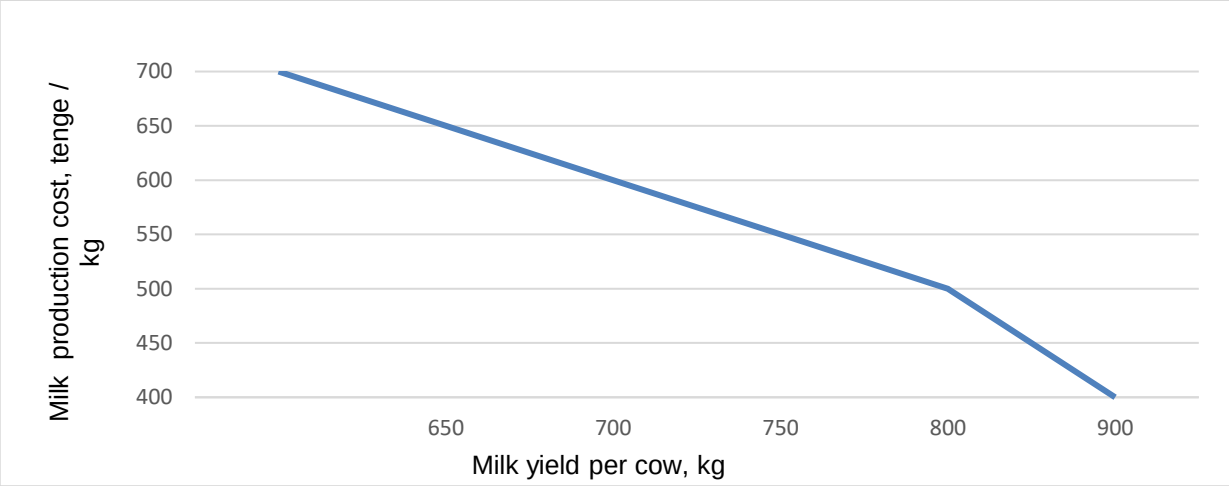
Table 4 - Relationship between KPIs and digitalization

Indicator	Small	Medium	Large
Use 1C	58	78	100
Zootechnical programs	6	33	75
Automatic milking	0	11	50
BI analytics	0	6	38
Note: compiled by the author based on the results of a survey of agricultural enterprises in the Akmola region (2024–2025)			

Large farms demonstrate higher milk yields and lower production costs thanks to digital productivity monitoring. Small farms do not use KPIs as a management tool, which exacerbates the crisis (figure).

The graph displays an inverse nonlinear relationship between cow productivity and milk production costs. A decline in milk yield from 889 to 635 kilograms per cow was concomitant with an escalation in production costs from 372 to 716 tenge per kilogram. Concurrently, total costs exhibited a mere 11.7% increase, while the cost price experienced a substantial 92% rise. This finding corroborates the biological and economic particularities inherent to milk production. Specifically, productivity functions as a multiplier of costs, and its decline engenders a disproportionate escalation in unit costs.

Consequently, the "costs → milk yield → cost price" model has been empirically validated by regional statistical data, thereby substantiating the necessity for a strategic accounting and analytical system that is centered on herd productivity management.



Note: developed by the author based on empirical survey data and model-based calculations of dairy farm performance

Figure - Dependence of milk production costs on cow productivity

The analysis demonstrated that the identified relationship between declining productivity and rising costs is not an accident but rather systemic, attributable to the biological and economic nature of dairy production. In contrast to industries that employ direct technological processing of resources, the financial costs associated with dairy farming do not directly translate into products. Their transformation is carried out through the biological mechanism of herd functioning. In this regard, the conventional linear accounting logic of "costs → cost price" is methodologically incomplete.

To reflect the actual cause-and-effect structure of dairy production, a two-level structural integration model has been proposed, based on the interrelationship between resource inputs, biological processes, and economic outcomes.

The first level examines the farm's resource inputs, including feed, labor, veterinary services, energy, and depreciation. These resources form the cost base of production and determine the technological and organizational conditions for dairy farming.

At the second level, costs are transformed through the biological processes of herd management. This level is characterized by feeding and husbandry parameters, such as the energy value of the diet, feed quality, the animals' health status, and the technologies employed. These factors directly influence the biological outcome, expressed by herd productivity indicators: milk yield per cow, herd retention, and reproduction rate.

The biological result determines the gross milk production volume, calculated as the product of average milk yield per cow and herd size ($Q = Y \times N$). In turn, the economic result is expressed in the cost of production, defined as the ratio of total costs to production volume ($C = Z / (Y \times N)$).

Thus, the model demonstrates that costs influence economic performance indirectly - through productivity. This confirms that herd productivity is a key link between resources and cost efficiency and should be regarded as a central indicator in strategic management accounting.

Consequently, the economic viability of dairy farming is contingent not on the absolute magnitude of expenses, but rather on the efficiency with which these expenses are converted into productivity. The model presented herein has the capacity to transform milk yield from a mere production indicator into a strategic management indicator, thereby linking the technological, biological, and financial parameters of the system.

Integration of this model into management accounting involves a transition from cost recording to productivity factor analysis. This forms the methodological basis of a digital accounting and analytical system that combines zootechnical and financial data and enables cost management through biological result management. The integration of this model into management accounting signifies a transition from a cost-recording approach to a focus on productivity analytics as a strategic Key Performance Indicator (KPI).

Discussions

The findings of the study demonstrate that the decline in the efficiency of dairy farming in the Akmola region is systemic in nature and is attributable to a combination of biological, structural and managerial factors. The dynamics of herd productivity exhibited a negative

trend, which, when coupled with relative stability or growth in costs, resulted in an accelerated increase in the cost per unit of production. This relationship is consistent with the findings of international studies, which indicate that productivity is a key economic multiplier of costs in dairy production. The identified discrepancy between costs and biological outcomes signifies a deterioration of the feed base and inadequate efficiency of diets, thereby diminishing the return on invested resources.

Preliminary structural analysis has confirmed the significant presence of small farms in the region. These farms are characterized by limited opportunities for technological modernization and the introduction of contemporary management methods. This has the effect of exacerbating industry heterogeneity, leading to a disparity in production efficiency between groups of farms. The survey results indicated that digitalization is characterized by fragmentation, with a primary focus on accounting processes. Additionally, production data is virtually not integrated into the management analytics system. The absence of adequate forecasting instruments and productivity key performance indicators (KPIs) impedes agricultural enterprises' capacity to engage in strategic management.

Consequently, the crisis phenomena are not solely attributable to economic challenges, but also to inadequate information integration. This underscores the necessity for a strategic accounting and analytical model that prioritizes productivity management and digital support for management decisions.

Conclusion

The study demonstrated that the structural crisis in dairy farming in the region is attributable to three factors:

1. The study confirms that the structural crisis in dairy farming is driven by declining herd productivity combined with a disproportionate increase in unit costs.

2. It is demonstrated that herd productivity functions as a key economic determinant of cost formation, acting as a multiplier that directly affects cost efficiency and sustainability.

3. A significant gap between cost accounting and biological indicators is identified, caused by the low level of digitalization and the lack of integration of production and financial data.

4. The theoretical contribution lies in substantiating a shift from traditional cost accounting to a productivity-oriented strategic accounting framework that integrates biological and economic parameters.

5. The practical contribution is reflected in the proposed integrated model “costs – productivity – cost of production”, implementation of which requires digital transformation, enhanced data integration, and alignment of managerial decisions with productivity and cost-efficiency indicators.

Conflict of interests: the corresponding author declares that this article does not involve any conflict of interest.

References

[1] Steeneveld, W. Invited review: Quantifying multiple burdens of dairy cattle production diseases and reproductive inefficiency – Current knowledge and proposed metrics / W. Steeneveld, B.H.P. van den Borne, A. Kok, T.B. Rodenburg, H. Hogeveen // Journal of Dairy Science. – 2024. – Vol.107. – N11. – P. 8765–8795. https:// doi.org/ 10.3168/jds.2023-24538

[2] Tschopp, R. longitudinal study of cattle productivity in intensive dairy farms in Central Ethiopoa / R. Tschopp, G. Gemechu, L.N. James // Frontiers in Veterinary Science. – 2021. – Vol. 8. – Article 698760. https:// doi.org/ 10.3389/ fvets. 2021.698760

[3] Management’s Discussion and Analysis and Consolidated Financial Statements June 30, 2022 [Electonic resource]. - 2023. Available at: https://www.ifc.org/content/dam/ifc/doc/ 2023/ FY22-Annual-MDA-and-FS-final.pdf (date of access: 11.03.2023).

[4] Porciello, J. Digital agriculture services in low- and middle-income countries: A systematic scoping review / J. Porciello, S. Coggins, E. Mabaya, G. Otunba-Payne // Global Food Security. – 2022. – Vol. 34. – Article 100640. https: //doi. org/10.1016/j.gfs.2022. 100640

[5] Manzoor, F. Digital agriculture technology adoption in low and middle-income countries: a systematic review / F. Manzoor, W. Longdao, S. Mahwish // Frontiers in Sustainable Food Systems. – 2025. – Vol. 9. -Article 103389 https://doi.org/10.3389/fsufs.2025.1621851

[6] Chamorro-Padial, J. A systematic review of open data in agriculture / J. Chamorro-Padial, R. García, R. Gil // Computers and Electronics in Agriculture. – 2024. – Vol. 219. – Article 108775. https://doi.org/10.1016/j.compag.2024. 108775

[7] Umbitaliev, A.D. Sustainable development of agro-industrial complex: management strategy / G.J. Toiauova, D.A. Kulanova // Problems of AgriMarket. – 2025. – № 1. – P. 14–26. https://doi.org/10.46666/2025-1.2708-9991.01

[8] Joao, H.C. Symposium review: Precision technologies for dairy calves and management applications / H.C. Joao, C.Melissa, W.Heather // Journal of Dairy Science. – 2021. – Vol. 104.- Issue 1. – P. 1023-1219. https:// doi.org/ 10.3168 /jds.2019-1788

[9] Konuspaev, R.K. Result-oriented digitalization in livestock production sector of the republic of kazakhstan / Konuspaev R.K., A.T.

Baigarina, T.A. Taipov // Problems of AgriMarket. – 2021. – № 4. – P. 55–56. https://doi.org/10.46666/2021-4.2708-9991.05

[10] Peña-Holguín, R.R. Smart Agriculture: Adoption of IoT Technologies by Farmers / R.R. Peña-Holguín, C.A. Vaca-Coronel, R.M. Farías-Lema, S.V. Zapatier-Castro, J.D. Valenzuela-Cobos // Agriculture. – 2025. – Vol. 15. – N 15. – Article 1679. https://doi.org/10.3390/agriculture15151679

[11] Manzoor, F. Digital agriculture technology adoption in low and middle-income countries — A review of contemporary literature / F. Manzoor, L. Wei, M. Siraj, X. Lu, G. Qiyang // Frontiers in Sustainable Food Systems. – 2025. – Vol. 9. – Article 1621851. https://doi.org/10.3389/fsufs.2025.1621851

[12] Porciello, J. Digital agriculture services in low- and middle-income countries: A systematic scoping review / S. Coggins, E. Mabaya, G. Otunba-Payne // Global Food Security. – 2022. – Vol.34. – Article 100640. https:// doi.org/ 10.1016/j. gfs.2022.100640

[13] Nassyrkhanova, B.K. Milk and dairy products market in akmola region of kazakhstan / B.K. Nassyrkhanova, A.S. Belgibaeva// Problems of AgriMarket. – 2020. – № 4. –P. 125–132. https://doi.org/10.46666/2020-4-2708-9991.15

[14] Belgibaeva, A.S. Ensuring food security in dairy market of the republic of kazakhstan / A.S. Belgibaeva // Problems of AgriMarket. - 2025. – № 1. – P. 61–69. https://doi.org/10.46666/ 2025-1.2708-9991.05

[15] International Farm Comparison Network (IFCN) Dairy Report 2024. –Kiel: IFCN Dairy Research Center, 2024. – 200 p.

[16] International Federation of Accountants (IFAC). International Good Practice Guidance // Strategic Management Accounting.- New York: IFAC, 2021. – 21 p.

[17] Kaplan, R.S. The Balanced Scorecard: Translating Strategy into Action. Boston / R.S. Kaplan., D.P. Norton.- Boston, Massachusetts: Harvard Business School Press, 2020.–322 p.

References

[1] Steeneveld, W., van den Borne, B.H.P., Kok, A., Rodenburg, T.B. & Hogeveen, H. (2024). Invited review: Quantifying multiple burdens of dairy cattle production diseases and reproductive inefficiency – Current knowledge and proposed metrics. *Journal of Dairy Science*, 107 (11), 8765–8795. https://doi.org/10.3168/jds.2023-24538 [in English].

[2] Tschopp, R., Gemechu, G. & James, L.N. (2021). Longitudinal study of cattle productivity in intensive dairy farms in Central Ethiopia. *Frontiers in Veterinary Science*, 8, 698760. https://doi.org/ 10.3389/fvets.2021.698760 [in English].

[3] Management's Discussion and Analysis and Consolidated Financial Statements June 30, 2022 (2023). Available at: https://www.ifc.org/content/ dam/ ifc/doc/2023/FY22-Annual-MDA-and-FS-final.pdf (date of access: 11.03.2023) [in English].

[4] Porciello, J., Coggins, S., Mabaya, E. & Otunba-Payne, G. (2022). Digital agriculture services in low- and middle-income countries: A systematic scoping review. *Global Food Security*, 34, 100640. https://doi.org/10.1016/j.gfs.2022.100640 [in English].

[5] Manzoor, F., Longdao, W. & Mahwish, S. (2025). Digital agriculture technology adoption in low and middle-income countries: a systematic review. *Frontiers in Sustainable Food Systems*, 9, 103389. https://doi.org/10.3389/fsufs.2025.1621851 [in English].

[6] Chamorro-Padial, J., García, R. & Gil, R. (2024). A systematic review of open data in agriculture. *Computers and Electronics in Agriculture*, 219, 108775. https://doi.org/10.1016/j.compag.2024.108775 [in English].

[7] Umbitaliev, A.D., Toiauova, G.J. & Ku-lanova, D.A. (2025). Sustainable development of agro-industrial complex: management strategy. *Problems of AgriMarket*, 1, 14–26. https://doi.org/10.46666/2025-1.2708-9991.01 [in English].

[8] Joao, H.C., Melissa, C. & Heather, W. (2021). Symposium review: Precision technologies for dairy calves and management applications. *Journal of Dairy Science*, 104(1), 1023-1219. https://doi.org/10.3168/jds.2019-1788 [in English].

[9] Konuspaev, R.K., Baigarina, A.T. & Taipov, T.A. (2021). Result-oriented digitalization in livestock production sector of the Republic of Kazakhstan. *Problems of AgriMarket*, 4, 55–56. https:// doi.org/ 10.46666/2021-4.2708-9991.05 [in English].

[10] Peña-Holguín, R.R., Vaca-Coronel, C.A., Farías-Lema, R.M., Zapatier-Castro, S.V. & Valenzuela-Cobos, J.D. (2025). Smart Agriculture: Adoption of IoT Technologies by Farmers. *Agriculture*, 15 (15), 1679. https://doi.org/10.3390/agriculture15151679 [in English].

[11] Manzoor, F., Wei, L., Siraj, M., Lu, X. & Qiyang, G. (2025). Digital agriculture technology adoption in low and middle-income countries — A review of contemporary literature. *Frontiers in Sustainable Food Systems*, 9, 1621851. https://doi.org/10.3389/fsufs.2025.1621851 [in English].

[12] Porciello, J., Coggins, S., Mabaya, E. & Otunba-Payne, G. (2022). Digital agriculture services in low- and middle-income countries: A systematic scoping review. *Global Food Security*, 34, 100640. https://doi.org/10.1016/j.gfs.2022.100640 [in English].

[13] Nassyrkhanova, B.K. & Belgibaeva, A.S. (2020). Milk and dairy products market in akmola region of kazakhstan. *Problems of Agri Market*, 4, 125–132. https://doi.org/10.46666/ 2020-4-2708-9991.15 [in English].

[14] Belgibaeva, A.S. (2025). Ensuring food security in dairy market of the Republic of Kazakhstan. *Problems of AgriMarket*, 1, 61–69.

https:// doi.org/ 10.46666/ 2025-1.2708-9991.05 [in English].

[15] International Farm Comparison Network (IFCN). (2024). IFCN Dairy Report 2024. *Kiel: IFCN Dairy Research Center*, 200 [in English].

[16] International Federation of Accountants (IFAC) (2021). International Good Practice Guidance: Strategic Management Accounting. *New York: IFAC*, 21 [in English].

[17] Kaplan, R.S. & Norton, D.P. (2020). The Balanced Scorecard: Translating Strategy into Action. *Boston, Massachusetts: Harvard Business School Press,* 322 [in English].

Information about author:

Bekbossynova Luiza – **The main author**; Ph.D student; Lecturer of the Educational Programs of Finance, Accounting and Auditing; S. Seifullin Kazakh Agro Technical Research University; 010000 Zhenis Ave., 62, Astana, Kazakhstan; e-mail: l.bekbossynova@kazatu.edu.kz; https://orcid.org/0009-0003-0132-2618.

Автор туралы ақпарат:

Бекбосынова Луйза Жапбаровна – **негізгі автор**; Ph.D докторанты; "Қаржы, есеп және аудит" Білім беру бағдарлама тобының оқытушысы; С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті; 010000 Жеңіс даңғ., 62, Астана қ., Қазақстан; e-mail: l.bekbossynova@kazatu.edu.kz; https://orcid.org/0009-0003-0132-2618.

Информация об авторе:

Бекбосынова Луйза Жапбаровна – **основной автор**; Ph.D докторант; преподаватель Группы образовательных программ: «Финансы, учет и аудит»; Казахский агротехнический исследовательский университет им. С. Сейфуллина; 010000 пр. Женис, 62, г.Астана, Казахстан; e-mail: l.bekbossynova@kazatu.edu.kz; https://orcid.org/0009-0003-0132-2618.