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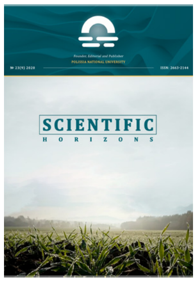

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Innovation enterprise development strategy in animal husbandry

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Abstract. The research relevance is determined by the need to create a strategy for the development of innovative entrepreneurial structures in livestock farming, the application of which can significantly increase the economic return on farms. The study aims to develop a strategy for the development of progressive livestock farms. The following general scientific methods were used for the study: analysis, synthesis, deduction, induction, and generalisation. Among the innovations considered were various genetic studies to improve the animal genome (the amount of meat and milk, the efficiency of feed assimilation), as well as the selection of genetically healthy embryos for breeding; the use of modern technologies in livestock farming, such as Radio Frequency Identification, Augmented Reality, Convolutional Neural Networks and Global Positioning System; technologies aimed at automating animal feeding processes. Particular attention was paid to various livestock monitoring systems created using advanced algorithms. A strategy for the development of innovative livestock farms was also presented, with drones, CCTV cameras, mixed reality glasses

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and scanner gloves as the main elements. Other necessary elements included a drone control module and software. Relevant calculations to prove the feasibility of implementing this strategy and its financial potential were also carried out. Provided that 82 units of various equipment are used, with a total cost of $187,970, the strategy provides for a profit of $1,072,030, with a 3-year implementation period and a payback period of less than 6 months. The practical significance of the information obtained is that it can be considered by researchers to further study the specifics of implementing innovative projects in livestock production, as well as to further develop various strategies for agricultural modernisation in Kazakhstan

Keywords: modernisation of farms; breeding traits; automated feeding systems; balanced rations; smart agriculture

INTRODUCTION

In Kazakhstan, agriculture plays an important role in the economic development of the country. There is still a relatively high level of private employment in livestock farming in some regions, and there are several farms specialising in the breeding of specific animals. Nevertheless, there is a certain chaotic approach and direction in the field of innovative projects related to this sector of agriculture, which undoubtedly slows down its development and prevents the active implementation of a comprehensive and systematic approach such as “smart” agriculture.

The topic of various innovative approaches in animal husbandry in Kazakhstan has been of interest to researchers such as O. Radchenko *et al.* (2023). Their study presents the concept of an automated pig feeding system that can improve feed utilisation, optimise feeding processes and increase the overall economic viability of farming. Another group of researchers, consisting of A. Dossanova *et al.* (2022) noted that West Kazakhstan, which is oriented in particular towards livestock production, is developing more slowly due to outdated farming practices. Agricultural enterprises in this region do not apply modern methods of animal housing and feeding, as well as technologies that could increase productivity and improve product quality. In a study conducted by E. Nasambaev *et al.* (2022), breeding farms in West Kazakhstan including Aisulu farm, Khafiz farm, Dongelek farm and Plemzavod Chapaevsky LLP were considered. The main objective of the study is to collect data on young Kazakh white-headed cows in different calving seasons. The development of young cows was studied monthly, including the morning weighing of calves before feeding and water supply. According to the data obtained, different calving results were observed on each farm depending on the time of year, which needs to be considered when planning more efficient herd renewal.

S. Bostanova *et al.* (2022) studied the dairy herd of Aina farm, and the milk produced. They found a tendency to decrease the fat/protein ratio to less than 1.1:1, which may be a consequence of consumption of an energy-rich but nutrient-deficient diet. Analysis of cow feeding on this farm indicates the predominance of a silage-concentrate feeding strategy, which mainly satisfies the energy and nutrient requirements of the animals. However, there is a deficiency of sugar, excess crude protein and starch and excess dry matter in the diet. It is observed that increasing the proportion of roughage and succulent forages in the herd’s diet and improving the quality of haylage and silage in this case are necessary conditions for improving the quality of dairy production on the farm. Thus, the study demonstrates the possibility of an innovative approach to assessing the quality of cow nutrition through chemical analysis of milk composition. In a study conducted by M. Amandykova et al. (2023), the application of breeding trait analysis of meat-wool sheep in Kazakhstan was considered. The analysis identified regions in the genome structure associated with meat and wool quality, which is an important step in improving the breeding performance of the Kazakh fleshing sheep breed.

Despite significant research in various spheres of livestock production in Kazakhstan, specific strategies for the development of innovative entrepreneurial structures in livestock production in Kazakhstan are not often considered, although the creation and development of such strategies is one of the important directions of scientific research in the field of agriculture. Thus, the study aims to create a strategy for the development of innovative entrepreneurial structures in livestock farming.

MATERIALS AND METHODS

The following methods were used to investigate innovative entrepreneurial structures in livestock production: analysis, synthesis, deduction, induction, and generalisation. The analysis was used to examine in detail progressive methods and practices of livestock farming, including different approaches to the organisation of herd feeding, quality monitoring of animal health and comfortable stay of animals in pens, barns and other specially prepared buildings and premises. The analysis was also used to consider the economic feasibility and feasibility of particular technologies in the context of the active development of progressive livestock farms. Synthesis was used to bring together the techniques and innovations in livestock production identified in the analyses, as well as the specifics of their implementation in practice and related issues of efficiency, feasibility, and payback, for possible further application in the strategy. Synthesis was also used to structure information on the different approaches to livestock monitoring, which differ from each other in terms of the technical aspect of achieving the desired efficiency and accuracy in fulfilling the objectives of the system.

In the process of investigating innovative approaches, methods and technologies in livestock production, deduction was integral to a more in-depth analysis. Through the use of deduction, the innovations identified in the synthesis process were analysed in more detail. This method also allowed a closer look at the information on specific innovations and best practices applied in the organisation of production on farms, which was necessary for the development of the strategy. An important aspect is the adaptation of farms to current trends, which was also examined using this method. The individual pieces of information were systematised and grouped to provide a more structured overview of new approaches and technologies in livestock production. The use of induction in the study was aimed at developing an overview of trends in livestock production and related research and technologies. Induction was also applied in forming similar conclusions regarding the features of innovative approaches to feeding, breeding and selection of different animal species such as cows, pigs, sheep, and horses highlighted in the synthesis.

Induction allowed the systematisation and synthesis of the information obtained, which was subsequently used for strategy development. Consideration of the specific application of innovations in the care and breeding practices of different livestock species was also carried out using induction, which enabled the identification of general trends and perspectives for the industry as a whole. The application of generalisation was a crucial step in structuring all the identified features relating to progressive farms. This method was also purposefully used to generalise the vast majority of the characteristics associated with each of the aspects identified in the study on the actual implementation of the innovations considered in the development strategy of progressive entrepreneurial structures in livestock production. The generalisation also allowed for the creation of a systematic overview, identifying key features and general trends inherent in livestock innovation and development strategies for farms of this nature. In turn, this method of structuring the information contributed to a better understanding of the interrelationships between the different innovative aspects and their impact on the integrated development of enterprises in this area, based on the respective strategies.

The following formulas were also used in the study to make calculations: equipment cost per cow per year, costs for each element, total savings on all elements, profit, and the required payback period in months. Equipment cost per cow per year (1):

$$x = (a \cdot b)/100, \tag{1}$$

where a – cost of 1 unit of equipment; b – number of required equipment per 100 cows; x – cost per 1 cow per year.

Costs for each element (2):

$$y = (c \cdot d), \tag{2}$$

where c is the cost of one of the strategy elements; d is the amount of equipment needed for n heads; y is the cost.

Total savings on all elements (3):

$$z = e1 + e2 + e3, \tag{3}$$

where $e1$, $e2$, $e3$ – savings on different elements per 1 cow per year; z – total savings on all elements.

Profit (4):

$$f = z - g, \tag{4}$$

where z – total savings on all elements; g – total acquisition costs of all elements; f – profit.

Required recouping period in months (5):

$$h = g/(i/12), \tag{5}$$

where g – total acquisition costs of all elements; i – total savings on all elements per year; h – required period for payback in months.

RESULTS

A significant number of technological innovations have been successfully introduced in the livestock sector in recent years, but only the most relevant innovations in this area will be considered to create a strategy for the development of innovative livestock farms. It should be noted that due to the widespread use of mobile and stationary sensors installed both on farm equipment and on the animals themselves, modern livestock technology provides operators with access to a variety of data. The amount of time spent on herd monitoring tasks is driven by the need for operators to carry personal computers, tablets, or smartphones to access the farm database. Currently, SmartGlove is a prototype with Level 3 technological readiness (capable of performing the assigned functions and confirming the feasibility of the concept), which is capable of scanning the unique code of an animal from a Radio frequency identification tag (RFID tag) and transmitting it to the Augmented Reality Support Group (ARSG), where all necessary information related to a specific animal is displayed (Fig. 1).

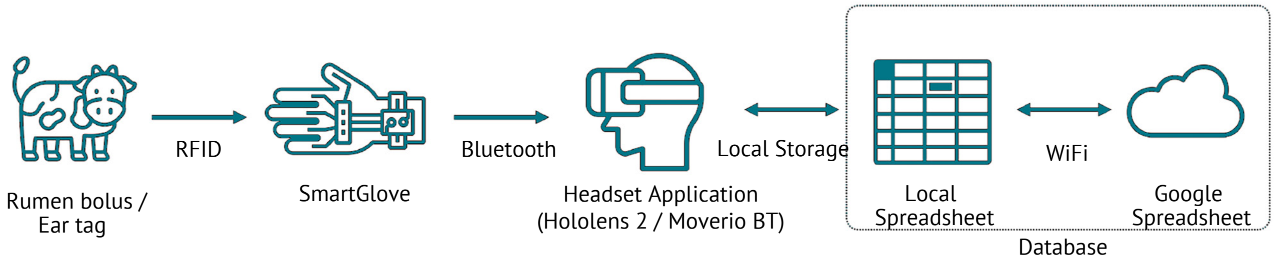

***Figure 1**. How SmartGlove operates*

***Source:** D. Pinna et al. (2023)*

The software solution includes three components: a database, a headset application, and a glove equipment manager. RFID tags placed in the rumen or ear are read using an RFID antenna attached to an Adafruit board embedded in SmartGlove. The animal's identification is transmitted to the headset via Bluetooth technology. When a new ID is received, the interface displays all available information about the corresponding animal stored in a database (Pinna *et al.*, 2023). Thus, this technology can be used to provide better care for each animal in the herd.

At the same time, in modern livestock farm management systems, video monitoring is becoming an increasingly important tool for qualitative assessment of cattle behaviour to monitor their health, predict calving and provide early medical attention. Traditionally, animal behaviour has been identified and monitored using a variety of sensors, but video cameras offer a potential alternative to sensors attached to the animals' bodies as they do not stress them. However, identifying and tracking specific cattle, especially those of similar black and brown colour, can be challenging. Considering that texture and colour effectively determine the appearance of an object, a coincidence matrix (CM) should be used for texture representation and the optimal colour space should be explored to extract colour moment information. Ultra-fine neural networks (CNNs) are applied to extract detailed features from recent cow photos, and the extracted features are combined in the tracking process to improve the performance of the system. In addition, an efficient multi-object tracking system that considers multiple characteristic colours of cows and behavioural patterns to effectively track their movements is also significant in this issue. Monitoring of daily activities such as time spent sitting or restless, frequency of drinking and feed intake, and posture of cows in a sitting position can provide valuable information to assess the health status of cattle (Mar *et al.*, 2023). Thus, video monitoring of herds using modern technology provides a unique opportunity to maintain herd health and performance.

It should also be noted that many embryonic developmental disorders in different species are predominantly due to genomic defects and anomalies. With the increasing number of equine embryos being created worldwide, it is now possible to analyse statistical data and evaluate, prioritise, and select individual embryos according to their genetic composition before transfer. While natural mating has long been the mainstay of traditional horse breeding, the rapid development of assisted reproductive technologies (ART) is having a significant impact on modern breeding tactics. The development of ART breeding in the late 19th century allowed the distribution and conservation of genetic material, and nowadays the rich gene pool is directly used in horse breeding, both in selection and breeding of specific breeds. Despite the development of technology, the efficiency of breeding with HRT is approximately 70%, but the use of preimplantation genetic testing (PGT), which involves analysing the genetic profile of the embryo before transfer, provides the opportunity to perform sufficient genetic analysis to detect defects in the genome. Preferring embryos with normal chromosomal and genomic composition for transfer selected by PGT for aneuploidies (PGT-A) may increase the frequency of foals. However, the use of PGT for structural chromosomal defects (PGT-SD), polygenic (PGT-P) or monogenic (PGT-M) traits and disorders allows the selection of only healthy embryos that have the desired characteristics before transfer (De Coster *et al.*, 2024). Thus, with advances in genetic research, more efficient breeding of horses is possible.

At the same time, a significant proportion of costs in sheep breeding is devoted to feed and improving feed utilisation efficiency can reduce overall production costs and increase economic profitability. Sheep (*Ovis aries*), a large ruminant animal, provide significant economic benefits to pastoralists through the production of meat, wool and other products. The popularity of mutton worldwide is due to its high protein content, low-fat content and juicy, appetising flavour. As feed costs account for approximately 65-70% of the total costs of sheep production, the efficiency of large sheep farms depends directly on the rational use of feed. Farmers therefore need to optimise their feeding processes. First of all, this can be done by paying attention to the efficiency of feed utilisation, which is largely dependent on metabolism and fat accumulation. Two genes, PLIN1 and MOGAT1, which play a key role in lipid metabolism, were found to have a significant impact on these processes. In Qinchuan cattle, polymorphisms in the PLIN1 gene were found to cause different carcass characteristics such as breast depth, subcutaneous fat thickness and intramuscular fat. In turn, MOGAT1, by regulating the conversion of free fatty acids to triglycerides, controls the release of fatty acids from adipose tissue (Ma *et al*., 2024). Thus, genetic studies contribute to further breeding and selection of more appropriate and economically viable sheep diets.

Precision livestock farming uses technological advances, such as digitalisation, to provide products that meet safety and sustainability requirements. It enables agriculture to actively contribute to public welfare through innovations in animal care and farm management. With the development of awareness among farmers and their professional advisors of the benefits of information and communication technologies, it is possible to encourage them to upload a variety of data to central repositories. These data, including information on diseases, fertility, feed intake and meteorological parameters, provide valuable information for decision-making in animal health and production. At the same time, the development of animal behaviour data collection, also illustrated by the AutoPlayPig project, highlights the importance of using information technology to monitor animal welfare in pig breeding with technologies such as cameras, microphones and sensors used to assess health and track animal movements (Kopler *et al*., 2023).

The significant development of energy supply systems in agriculture has a significant impact on the development of this sector. Progress in the process of agricultural electrification is supported by modern technologies and is an important factor in the history of agriculture, where significant transformations have always depended on the emergence of new energy sources. Thus, one of the fundamental conditions for the regular and stable development of rural areas and agricultural production is the provision of electricity. The integration of agriculture and the energy industry is a viable business model with great potential for economic growth, contributing to the financial rewards of the sector. In the livestock sector, such a model can be applied to set up automated farms that utilise green energy. From a business perspective, this model reinforces the positive effects that agriculture has on the food supply processes of the population, while also caring for the environment (Fu & Niu, 2023).

In 2022, more than twenty digital farms and approximately one hundred and seventy innovative farms were active in Kazakhstan. To complete the process of digitalisation in the agricultural sector, the country's Ministry of Agriculture has expressed its intention to create another four thousand innovative farms and at least twenty digital farms by 2023. The main objective of this transformation is to achieve full automation of government services and operations in this sector. Although most farms in the country currently operate using conventional or outdated technologies, the process of digitalisation in agriculture is already well underway. This can be seen, for example, in the ability to automate the care and monitoring of livestock, thanks to the emergence of new livestock technologies such as Global Positioning System (GPS)-trackers that, when used with smartphones, simplify the process of finding lost animals and enable herd location tracking (Dambaulova *et al.,* 2023). Unfortunately, the process of modernisation and development of livestock farming in Kazakhstan is not often covered in studies, media publications and statements by government officials, so it is not possible to adequately assess the extent to which the objectives have been met and the state of the industry in the creation of digital and innovative farms.

Thus, to create a strategy for the development of innovative entrepreneurial structures in the livestock sector, a progressive research area such as digitalisation should be considered. Digitalisation consists of the creation of electronic databases with various animal characteristics in the region and related epidemiological conditions, as well as the application of remote monitoring systems for the herd using modern technologies, from GPS trackers and video cameras to animal analysis and identification systems based on ultra-precise neural networks. Based on the innovations and their directions, it is possible to propose the following strategy for livestock farms that have a basic set of equipment in the form of a computer and a stable connection to electricity and the Internet. It should also be noted that some of the elements can be used in a more comprehensive combination in the future, but this will require additional customisation and improvement. The strategy includes a plan to gradually build up the following elements over a period of three years: drones, drone control modules, glove scanners, mixed reality goggles, CCTV cameras, and software (Table 1).

***Table 1**. Cost of individual elements of the strategy*

No.	Element description	Equipment costs	Cost per cow per year	Savings per cow per year
1	Drones (HZH C680)	$8,000	$80	-
2	Drone control module (Skynode X)	$1,600	$1.6	-
3	Scanner glove (SmartGlove)	~$40	$1.2	-
4	Augmented reality headset (HoloLens 2)	$3,500	$105	-

Table 1. Continued

No.	Element description	Equipment costs	Cost per cow per year	Savings per cow per year
5	CCTV Camera (8MP IP Camera POE H.265 CCTV)	$17	$0.17	-
6	Software (CattleEye)	-	$1	$420

Source: *compiled by the authors based on R. Price (2023) and the article "Holy cow! CattleEye reduces EC2 cost by over 60% with Spot Scaling" (2022)*

Appropriate quantitative ratios were used to effectively utilise the elements: 1 drone per 100 cows, 1 drone control module per 10 drones, 3 scanner gloves and mixed reality goggles per 100 cows, 1 CCTV camera per 100 cows, and 1 copy of the software for all CCTV cameras. The cost per cow per year assumes purchase according to the digitalisation plan over a period of 3 years. Savings per cow per year are only shown in one case due to the need for pilot testing. The digitalisation plan foresees the amount of equipment needed to supply an innovative livestock farm of 1,000 animals (Fig. 2).

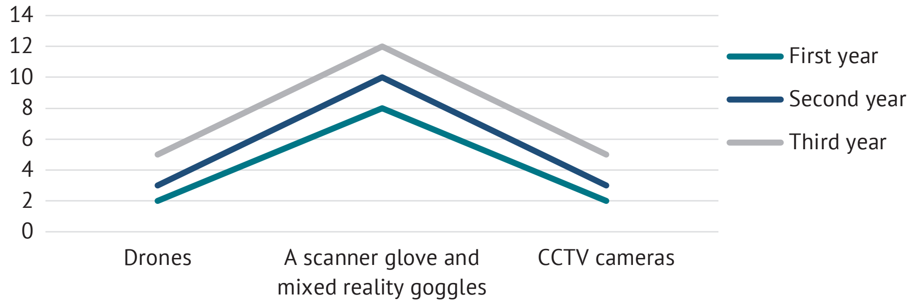

Figure 2*. Digitalisation plan for livestock farming over a period of three years*
Source: *compiled by the authors*

A total number of items required: 10 drones, 1 drone control module, 30 scanner gloves and mixed reality goggles, 10 CCTV cameras, and 1 copy of software for all CCTV cameras. The elements not mentioned in the visualisation of the digitalisation plan (drone control module, copy of software) are purchased in the first year of the strategy application. The total cost of the strategy, when applied to a farm of a thousand heads, is $187,970, for a saving of $1,260,000 (Table 2).

Table 2*. Detailing the cost of the strategy (for a farm of a thousand head)*

No.	Description of the element and its required quantity	Overall equipment cost	Overall savings
1	Drones (HZH C680) x 10	$80,000	–
2	Drone control module (Skynode X) x 1	$1,600	–
3	Scanner glove (SmartGlove) x 30	~$1,200	–
4	Augmented reality headset (HoloLens 2) x 30	$105,000	–
5	CCTV Camera (8MP IP Camera POE H.265 CCTV) x 10	$170	–
6	Software (CattleEye) x 1	–	$1,260,000

Source: *compiled by the authors*

Thus, the profit from the implementation of this strategy is $1,072,030, with an implementation period of 3 years and a payback period of less than 6 months. It should be noted that digitalisation is the most technologically and economically costly of the modernisation processes, yet it offers access to advanced systems for monitoring vital signs of the herd, which significantly reduces costs in terms of proper control of herd health.

DISCUSSION

Various technologies such as drones, CCTV cameras, glove scanners, drone control modules and camera software have been incorporated into the developed strategy. Several other innovative technologies can be used for this kind of strategy.

Among the research on such technologies, the study of D. Wu *et al.* (2023), considers automated respiratory monitoring of dairy cows and claims that it helps to increase the degree of automation of their health assessment and also reduces manual labour. The reasoning states that cows are often crowded on farms, and this creates difficulties for conventional health monitoring due to the physical limitation of free view and access to the cows. In turn, the automated method of tracking cows' breathing, in addition to measurements of blood pressure, blood oxygen level, body temperature and electrocardiogram, is one of the key indicators of animal health, which also serves as a significant indicator of the normal course of vital processes in the animal's body. The manifestation of these processes is the synchronous movement of the abdomen when breathing characteristics change – this phenomenon is known as "respiratory behaviour". Monitoring the respiratory behaviour of dairy cows is a difficult task due to less intensive respiratory processes, which makes their breathing more difficult to observe, especially when the number of observed cow increases. But these issues are addressed by introducing more advanced approaches to recognise the resting state of each cow (lying or standing position), for which CNNs and bi-directional long-term and short-term memory algorithms are integrated, using the You Only Look at Coefficients (YOLACT) algorithm for multi-cow image recognition and segmentation. In this way, ultra-precise neural systems are utilised in interaction with any advanced algorithms and applied to various animal vital signs monitoring systems using video cameras. As can be seen, algorithms for recognising certain data by analysing the image transmitted from cameras use different principles to perform certain functions efficiently, but common to them is the desire for more advanced and accurate analysis of video data, which determines the productivity and quality of each of them.

In turn, attention should be devoted to the study conducted by G.K. Dambaulova *et al.* (2023), which considered the possibility of improving the natural potential of animals, for which biotechnology, genomic analysis and DNA analysis are used in animal breeding to improve the genome of animals, as well as faster reproduction methods are introduced, which leads to the standardisation of cattle in general. In advanced countries that are major cattle producers, intensive breeding efforts have led to high results in the development of dairy cow breeds with milk yields of 8,000-10,000 kg or more and lactation lengths of more than 305 days. It was also noted that unmanned aerial vehicles are widely used in New Zealand agriculture to assist herders in herd management. These drones use loudspeakers and recorded dog barking sounds to assist in herd gathering. Likewise, with the application of more efficient land, forest and pasture management practices, smart farming techniques are helping to prevent soil erosion and avoid deforestation for pasture expansion, a prime example being the successful restoration of degraded farmland in Brazil, achieved through the Integrated Crop, Livestock and Forestry Systems (ICLFS) programme, in a country that produces more than 23% of the world's cattle. Thus, the scientific community is actively considering innovation and emphasising the opportunities offered by modern technologies in genetic research and digitalisation. Particular attention should be paid to the use of drones, as it is their use that makes it possible to respond effectively and in a timely manner to unfavourable situations that animals may get into during free grazing. They are also indispensable in the search for lost individuals, as they can provide a wide field of view from a height, but it is prone to be affected by weather conditions.

R.C. Chebel *et al.* (2024) note that along with improvements in nutrition and care, advances in genetics and breeding approaches have a positive impact on breeding efficiency. The researchers also note the role of automated monitoring systems that are used in the selection of cows for breeding on genetic and physiological parameters. It is also possible to note that a thoughtful approach to the introduction of innovative technologies is their important feature, as they are more sensitive to poor quality management, especially those that work in a system and disabling one of its elements does not allow to fully utilise the others or apply them at all.

In turn, N. Widaningsih *et al.* (2023) state that precision livestock management, which is a set of modern electronic tools and techniques used in livestock management to promote sustainable practices in agriculture and livestock production, when used in conjunction with automated livestock management systems, has a positive impact on the efficiency and productivity of livestock systems. It is difficult to disagree with this, as any of the innovations mentioned in the study has a positive impact on farm performance to a greater or lesser extent, but the main issue remains the amount of capital investment required for their implementation, which in general is the economic feasibility. Despite this, most of the innovative technologies, when properly implemented, show quite good payback periods.

According to C. Bader and H. Bernhardt (2023), due to the increasing global demand for energy resources, the latter is becoming an urgent problem for the entire agricultural industry, and this has a significant impact on the economic situation of livestock farms. In turn, biogas plants represent a potential solution capable of generating additional energy by processing manure. Another option is the installation of photovoltaic systems on the roofs of farm buildings. This approach allows us to efficiently utilise low-cost energy sources on the farm and to actively participate in the energy market by supplying the generated energy directly to the general grid. It is hard to disagree with this view, as it is a direct example of the use of green energy technologies. Since the energy costs of innovative farms are comparatively higher than those of conventional farms, the use of "green" sources of electricity can significantly reduce costs in this aspect.

At the same time, according to F.A. Kurniadi *et al.* (2023), with increasing farm size, there is a need for an effective livestock monitoring system, especially in cases where the animals are on pasture or in paddocks instead of in specific facilities. To address this problem, the application of YOLOv5 method is proposed to analyse drone images. To ensure detection efficiency, a training process is performed on a dataset consisting of cow photos and the hyperparameters of the algorithm are tuned to achieve optimal results. Thus, YOLOv5 is an object detection model designed to recognise cows on farms from drone images. Indeed, different algorithms can be applied not only on fixed video cameras but also directly integrated into drones, for better herd monitoring. The recognition of specific individuals can also be applied to further develop the automation of drone use, potentially offering a herd monitoring system completely independent of human intervention.

V. Naujokienė *et al.* (2022) noted that in the production of fodder concentrates, grass silage and maize silage they are significantly affected by fertilisers. The application of integrated smart management identified these critical points, after which bioproducts replaced 50% of nitrogen fertiliser as an experiment. The introduction of biopreparations has reduced the negative impact on grass, barley, hay, and maize used for silage. Thus, the concept of "smart" agriculture is also manifested in the harvesting of animal feed, which undoubtedly has a positive effect on the economic aspect of livestock production.

C. Manteuffel (2022) emphasises that the effective implementation of innovations in livestock production implies that these innovations must be economically justified. However, constraints related to biological, ethical, and environmental aspects limit the economic potential of a concept such as precision animal husbandry. At the same time, the utilisation of the solutions offered by this concept often requires the use of sophisticated sensor systems and evaluation methods, which increases the overall cost and payback periods of the technology. Yes, most modern technologies are indeed quite expensive, especially when it comes to implementing entire systems, but despite the long payback period of some technologies, their benefits can be utilised immediately after installation, and in some cases, innovative solutions can prevent significant costs associated with unforeseen on-farm situations such as epidemics.

CONCLUSIONS

Thus, a study of innovative entrepreneurial structures in livestock farming was conducted and a strategy for their development was proposed. In the course of the study, various innovative approaches to livestock farming, such as smart farming, were studied, and a variety of progressive proposals for the use of modern technologies in livestock farming were considered. The strategy developed was to gradually scale up innovative technologies within individual farms, regardless of their size. The main elements of the strategy are drones, sensor gloves, CCTV cameras and their mixed reality goggles, and CCTV cameras in the quantities required to optimally fulfil their functions. Most of the technologies involved require further experimental evaluation of their economic feasibility but based on the already available information about the effectiveness of some of them, as well as the cost of all the elements involved, it was possible to make appropriate calculations of costs, profits and payback period for a livestock farm of a thousand animals. The following figures should be noted: costs – $187,970, savings – $1,260,000, profit – $1,072,030, payback period – less than 6 months, implementation period – 3 years. Total equipment requirements, not counting the basic set: drones – 10 pcs, drone control module – 1 pc, glove-scanner – 30 pcs, mixed reality glasses – 30 pcs, CCTV cameras – 10 pcs, software – 1 copy.

Many of the innovative projects are not as financially costly for progressive farms but offer significant economic potential for cost reduction. It should be summarised that the topic of progressive farms and their development is of great importance for the development of this area in Kazakhstan, and also requires more detailed scientific substantiation and experimental application, as the improvement of the efficiency of livestock farming will have a beneficial impact on the economic situation in the state, bringing closer the full and widespread introduction of international standards and progressive technologies in agriculture in Kazakhstan.

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None.

CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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Стратегія розвитку інноваційних підприємницьких структур у тваринництві

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Анотація. Актуальність даного дослідження полягає в необхідності створення стратегії розвитку інноваційних підприємницьких структур у тваринництві, застосування якої може значно підвищити економічну окупність господарств. Мета дослідження – розробити стратегію розвитку прогресивних тваринницьких господарств. Для проведення дослідження було використано такі загальнонаукові методи: аналіз, синтез, дедукція, індукція та узагальнення. Серед розглянутих інновацій було виокремлено: різноманітні генетичні дослідження задля покращення геному тварин (кількість м'яса та молока, ефективність засвоєння корму), а також відбору генетично здорових ембріонів для розведення; використання у тваринництві таких сучасних технологій, як: Радіочастотна ідентифікація, доповнена реальність, нейронні мережі та система глобального позиціонування; технології, спрямовані на автоматизацію процесів годівлі тварин. Окрему увагу було приділено різним системам моніторингу поголів'я, створених з використанням просунутих алгоритмів. Також було представлено стратегію розвитку інноваційних господарств у тваринництві, основними елементами якої стали дрони, камери відеоспостереження, окуляри змішаної реальності та рукавички-сканери. Іншими необхідними елементами були обрані модуль управління дронами та програмне забезпечення. Також було проведено відповідні розрахунки, які доводять доцільність впровадження цієї стратегії та її фінансовий потенціал. За умови задіяння 82 одиниць різного устаткування, загальною вартістю 187,970$, стратегія передбачає прибуток у 1,072,030$, з періодом реалізації 3 роки та окупності менше 6 місяців. Практичне значення отриманої інформації полягає в тому, що вона може розглядатися дослідниками для подальшого вивчення особливостей реалізації інноваційних проєктів у тваринництві, а також і для подальшого розвитку різних стратегій у сфері модернізації сільського господарства в Казахстані

Ключові слова: модернізація господарств; селекційні ознаки; автоматизовані системи годівлі; збалансований раціон; «розумне» сільське господарство