EFFICIENCY OF IMPLEMENTATION OF SMART FARMS: ECONOMIC ASSESSMENT

СМАРТ-ФЕРМАЛАРДЫ ЕНГІЗУ ТИІМДІЛІГІ: ЭКОНОМИКАЛЫҚ БАҒАЛАУ

ЭФФЕКТИВНОСТЬ ВНЕДРЕНИЯ СМАРТ-ФЕРМ: ЭКОНОМИЧЕСКАЯ ОЦЕНКА

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Annotation. *The goal* is to study the mechanism for increasing the efficiency of production systems when fattening beef cattle. An example of the use of Smart Technology is given to determine and influence the quality of genetic selection of meat animals, which in turn contributes to high average daily gain and increased profitability of farms. The object of research - methods of keeping and feeding cattle, digital technologies and technical means, results of fundamental, theoretical, forecasting and search and applied scientific developments. *Methods* – comparative analysis, expert assessments, experience in applying promising trends and innovative technology of the Intergado system. *Results* – it is shown that the use of such nanotechnologies makes it possible, depending on the "key feature," to automatically generate databases of production processes through which the weight and condition of the livestock is monitored. Based on information about changes in the weight of cattle, timely adjustments are made to the animals' diet, which helps improve their health and optimize the genetic algorithm. Weighing cattle (BW) is an important tool in herd management since increasing body weight affects productivity, productivity and, as a result, readiness for speedy sale and savings in feed costs. *Conclusions* – digital solutions have been proposed to improve the effectiveness of regulation of agricultural production with a large flow of information and technological operations; model parameters make it possible to automatically transfer farm animals from one production group to another by tracking the "live weight" indicator for culling.

Аңдатпа. *Мақсаты* – етті ірі қара малды бордақылау кезінде өндірістік жүйелердің тиімділігін арттыру механизмін зерттеу. Етті бағыттағы малдарды генетикалық іріктеу

Agricultural policy: mechanism of implementation

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сапасына олардың әсерін анықтау және анықтау үшін Смарт-технологияларды қолдану мысалы келтірілген, бұл өз кезегінде шаруашылықтардың орташа тәуліктік өсіміне, рентабельділігінің өсуіне ықпал етеді. Зерттеу нысаны – ірі қара малды ұстау және азықтандыру әдістері, цифрлық технологиялар мен техникалық құралдар, орындалған іргелі, теориялық, болжамды-іздестіру және қолданбалы ғылыми әзірлемелердің нәтижелері. *Әдістері* – салыстырмалы талдау, сараптамалық бағалау, «Intergado» жүйесінің перспективалық үрдістері мен инновациялық техникасын қолдану тәжірибесі. *Нәтижелері* – мұндай нанотехнологияларды қолдану «негізгі белгіге» байланысты малдың салмағы мен жай-күйіне мониторинг жүргізілетін өндірістік процестердің дерекқорларын автоматты түрде қалыптастыруға мүмкіндік беретіні көрсетілген. Ірі қара малдың салмағының өзгеруі туралы мәліметтер негізінде малдардың рационына уақтылы түзетулер енгізіледі, бұл олардың денсаулығын жақсартуға, генетикалық алгоритмді оңтайландыруға көмектеседі. Ірі қара малды өлшеу (BW) табынды басқарудың маңызды құралы болып табылады өйткені дене салмағының артуы өнімділікке, өнімділікке және соның салдарынан жемшөп шығындарын тез сатуға және үнемдеуге дайындыққа әсер етеді. *Қорытындылар* - ақпараттың үлкен ағыны және технологиялық операциялар кезінде ауыл шаруашылығы өндірісін реттеудің тиімділігін арттыру үшін цифрлық шешімдер ұсынылған; модель параметрлері автоматты режимде ауыл шаруашылығы малдарын бір өндірістік топтан екіншісіне жою үшін «тірі масса» көрсеткішін қадағалау арқылы ауыстыруды жүзеге асыруға мүмкіндік береді.

Аннотация. *Цель* – изучение механизма повышения эффективности производственных систем при откорме крупного рогатого скота мясных пород. Приведен пример применения Смарт-технологии для определения и их влияния на качество генетического отбора животных мясного направления, что в свою очередь способствует высокому среднесуточному приросту, росту рентабельности хозяйств. Объект исследования – способы содержания и кормления КРС, цифровые технологии и технические средства, результаты выполненных фундаментальных, теоретических, прогнозно-поисковых и прикладных научных разработок. *Методы* – сравнительного анализа, экспертных оценок, опыт применения перспективных тенденций и инновационной техники системы «Intergado». *Результаты* – показано, что использование таких нанотехнологий позволяет в зависимости от «ключевого признака» автоматически формировать базы данных производственных процессов, посредством которых осуществляется мониторинг веса и состояния поголовья. На основе сведений об изменении веса крупного рогатого скота своевременно вносятся корректировки в рацион животных, что содействует улучшению их здоровья, оптимизации генетического алгоритма. Взвешивание КРС (BW) – важный инструмент в управлении стадом поскольку наращивание массы тела влияет на производительность, продуктивность и, как следствие, готовность к скорейшей реализации и экономии затрат на корма. *Выводы* – предложены цифровые решения для повышения результативности регулирования сельскохозяйственного производства при большом потоке информации и технологических операциях; параметры модели делают возможным в автоматическом режиме осуществление перевода сельхозживотных из одной производственной группы в другую путем отслеживания показателя «живая масса» для выбраковки.

Introduction. In Kazakhstan, in 2020, the share of beef cattle in the total livestock accounted for about 33.5%, including 30.8% in the Akmola region, 22.3% in Pavlodar and 16.2% in North Kazakhstan. This metric had been on the rise until 2020, but currently, there is a prevalent decrease. While Akmola region experienced a 1% decline, equivalent to 704 heads, in the number of beef cattle in 2022, North Kazakhstan and Pavlodar regions witnessed substantial reductions of 16.6% (equivalent to 10 025 heads) and 52.6%

(equivalent to 55 377 heads), respectively. Overall, in Kazakhstan, there was a significant reduction in the number of beef cattle, amounting to 1 539 728 heads, which represents a decrease of 2.4 times. Additionally, the proportion of beef cattle also decreased by 2.5 times [1,2]. It's important to highlight that approximately half, or around 50%, of all beef cattle in the mentioned regions are owned by peasant farms and households of the local population.

Thus, the progress of livestock farming in Kazakhstan faces four primary obstacles:

− firstly, the prevalence of livestock ownership in small-scale entities;

− secondly, the limited productivity of the livestock sector;

− thirdly, insufficient provision of feed;

− fourth, veterinary care is not at the proper level.

We see the solution to these problems in the use of digital Smart Technologies, which have recently been actively introduced in large farms of the country.

Material and methods of research. The basic research facility was «Novobratskoye» LLP of the Akmola region. The studies were conducted on Kazakh white-headed bulls (n=58) aged 18-21 months, who were fattening at an automatic feeding station.

The sensor system measures for 58 days how much the bull consumes feed and what weight gain it gives. Based on the analysis of these data, the best individuals are selected for sale, and outsiders are culled. This will allow the introduction of an index assessment of producer bulls. Based on the indices, buyers will be able to choose exactly the bull they need, based on the available breeding stock and the tasks of the farm itself. At this stage of development, it is possible to give a preliminary assessment of the dynamics of animal weight gain. The received data forms a database both on the platform itself and on the server in the Herd Management software.

This study is based on the materials of the basic economy, as well as satellite communication data related to the «Intergado» system, scientific publications of economists in the field of application of modern technologies and innovative equipment of the «Intergado» system in the economy. Various approaches have been used during the research: statistical analysis methods (comparison, absolute deviation, relative quantity). To determine a real assessment of the effectiveness of the use of Smart Technologies in research farms, a comparative analysis of quantitative and qualitative indicators before and after implementation was carried out.

The results of the analysis allow us to draw conclusions about the effectiveness of the introduction of new advanced technology in the meat sector, which implies an increase in the quality of agricultural products.

Results and their discussion. Smart Farm is a new concept that relates to the management of livestock of farm animals using modern information technologies to increase the quantity and quality of products, while optimizing the required human labor [3, 4].

Numerous digital technologies are applicable in agriculture. The key classifycation criterion for these technologies is their reliance on electronic computation for data processing and the utilization of electronic devices [5,6]. The results obtained during the research allow not only to evaluate the most effective digital technologies in animal husbandry, but also to identify systemic contradictions in the implementation and use of them (table 1).

Table 1 - SWOT analysis on Smart Farm technologies

	Positive impact	Negative impact
Internal environment	Strengths: - automated monitoring and watering, feeding, and reproduction systems; - optimization of production processes; - cutting down on feeding expenditures while enhancing labor efficiency; - supervision and management of animal health for the purpose of diminishing treatment expenses and minimizing livestock losses; - easing the workload on personnel through process automation, thereby reducing the time required for animal monitoring and care.	Weaknesses: -expensive and necessitating substantial investments in equipment and technology; - elevated electricity consumption: certain systems may require substantial electricity, leading to added expenses for energy supply; - rise in the expenses associated with Internet services.

External environment	Opportunities: - Smart Technologies can help reduce the risk of accidents and accidents at work, for example, safety monitoring and risk management systems can be used; -Smart Technologies can significantly affect profitability in beef cattle breeding if they are used correctly and effectively.	Threats: - cybersecurity risks: the use of the latest technologies can create new cybersecurity risks; - difficulty in management: managing Smart Farms may require additional skills and experience; - risk of technical failures: the use of automated equipment and Smart Systems can create risks of technical failures that can affect the productivity and reliability of production.

As the main effect expected from the technology of «Smart» animal husbandry, the majority of respondents indicated a reduction in costs (33%) and the safety of livestock by reducing the facts of the disposal of animals for reasons unrelated to production (21%), including theft, culling from the herd and other incidents (table 2).

Table 2 - Respondents' expectations from the use of «Smart» animal husbandry technology

Question / Answer options	Answer options answers	
	quantity	%
What are the main changes for your company (farm)? First of all, do you expect «Smart» agriculture technology to be applied?	116	100,0
Reduction of enterprise expenses	39	33.3
Improvement of livestock safety by reducing non-production disposals	24	20.6
Improvement of product quality	19	16.3
Improvement of the quality of management at the enterprise, including constant access to up-to-date information and control over resources	18	15.6
Increase in production volumes	14	16.2

At the same time, respondents noted that the technologies of «Smart» animal husbandry will lead to a potential increase in production volumes, expansion of opportunities for effective production management and reduction of livestock retirement.

As an example, we present the data of «Novobratskoye» LLP on the use of Smart Technology, namely the «Intergado» system. The patented «Intergado» technology offers a scientifically proven unprecedented ability to monitor animals continuously and automatically in real time, measure and predict their market value, as well as identify and treat animals without human intervention [7,8]. «Novobratskoye» LLP has been using the «Intergado» system since 2022 for the cultivation of meat cattle, and until 2022 they worked using traditional technology. If we talk about the «Intergado» system, it allows monitoring animal health and early detection of diseases by assessing changes in behavior and feed consumption, which in turn optimizes the use of natural, human, and financial resources (table 3) [9].

Table 3 - The cost of equipment and services under the «Intergado» system for 2022

Name	Quantity, unit	Price	Cost, US dollar /exchange rate 447,5	Cost, tenge
Weighing unit	4	5 138.17	20 552.68	9 197 324.3
Feeding unit	10	7 232.43	72 324.3	32 365 124.25
Data Processing Center	1	5 279.41	5 279.41	2 362 535.975
Total cost of the system:			98 156.39	43 924 984.53
broker services (customs duty, transport services, certification services)				1 665 440.00
Total				45 590 424.53

The «Intergado» system has a number of advantages. It will allow real-time monitoring of the herd and evaluation of bulls based on data such as animal weight, average daily

gain and residual feed intake, which allows timely decisions on the effectiveness of genetic selection.

The research results of individual scientists have shown that temperament affects the bodies of cattle and can have production and economic consequences to produce meat-beef [10,11]. According to the summary data from the «Intergado» system, since the type of temperament affects the average daily growth of bulls, cattle were grouped by weight and feeding. According to the results of the data obtained, the calmest bulls gain weight faster, therefore, they have a large average daily increase (table 4).

Table 4 - Grouping of data by weight, feeding from the «Intergado» system

Group by initial weight	Number of animals in the group	Temperament	Average feed intake	Average final weight	Number of animals in the subgroup
Up to 210	6	1	11.5	282.1	2
		2	7.1	296.4	1
		3	13.8	276.9	1
		4	12.2	303.0	2
210-260	43	1	11.1	288.3	9
		2	11.6	281.2	15
		3	10.9	299.6	9
		4	12.7	291.2	10
More than 260	17	1	12.7	257.6	4
		2	13.0	290.5	8
		3	14.1	275.5	5
		4	0		0

For the experiment, 70 bulls were delivered, but complete data was obtained from 66 animals. Which were divided into conditional three groups by initial weight. In the group with the lowest weight up to 210 kg, 6 bulls, with an average weight of 210-260 kg - 43 animals, and 17 bulls had an initial weight of more than 260 kg. To ensure result accuracy, a correlation analysis was conducted to examine the relationship between the various temperaments of bulls and their average daily weight gain, yielding a substantial correlation coefficient of R=0.97 (there is a close relationship) [12,13].

In the first group of animals, the best result was shown by the 4th type of temperament - with an average consumption of 12.2 kg of feed, the final result was the highest at 303 kg. In the same group of bulls, the animals with the 3rd type of temperament showed the worst result, since with a feed consumption of 13.8 kg, the final weight for this group was the lowest - 276.9 kg

In the second group - with an average weight of 210-260 kg, bulls with temperament of type 3 turned out to show the best result. Since the lowest feed consumption of 10.9 gave the highest final weight of animals in the volume of 299.6 kg. The worst result in the second group were animals with a final weight of 281.6 kg temperament type - 2 and consumption of 11.6 kg.

In the third group, in which the bulls had the highest initial weight of more than 260 kg, the highest final weight of 290.5 kg was found in animals with the type 2 temperament and feed consumption in the group on average 13.0 kg. In the same group, the final weight of bulls with temperament type 1 is low, since the final weight was 257.6 kg with an average consumption of 12.7 kg.

As can be seen, the analyzed data makes it possible to identify the best bulls and conduct breeding selection, which contributes to rapid effective weight gain in a shorter period, resulting in savings in livestock maintenance costs [14]. The composition and cost structure of beef cattle breeding in comparison with traditional technology is considered in table 5.

In «Novobratskoye» LLP, the costs amounted to 6 315.8 thousand tenge before implementation, and after implementation they were lower by 1 886.2 thousand tenge and amounted to 4 429.6 thousand tenge. The largest share in the farm is feed 36.4% before the introduction and after the introduction of 29.0%, as a result of rational feeding. There is an increase in wages by 29%, and the specific weight before the introduction of 31.7%, then after the introduction of 2 029.0 thousand tenge. Since digital technology requires the Internet, their costs amounted to 48.0 thousand tenge.

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Table 5 - Composition and structure of costs for beef cattle breeding in «Novobratskoye» LLP

Cost items	Before implementation		After implementation		Absolute change
	amount, thousand tenge	specific weight,%	amount, thousand tenge	specific weight, %	
Remuneration of labor with accruals	2 000.0	31.7	2 029.0	45.8	29.0
Services	525.1	8.3	80.0	1.8	-445.1
Fuel and lubricants	74.6	1.2	12.6	0.3	-62.0
Electricity	298.0	4.7	595.8	13.5	297.8
Amortization	464.7	7.4	120.0	2.7	-344.7
Animal protection products	262.6	4.2	231.2	5.2	-31.4
Other direct expenses	343.8	5.4	0	0	-343.8
Feed	2 300.1	36.4	1 283.2	29.0	-1 016.9
Coal	47.0	0.7	29.8	0.7	-17.1
The Internet			48.0	1.1	48.0
Total costs	6 315.8	100.0	4 429.6	100.0	-1 886.2
Average daily weight gain, grams	1 030		1 344		314
Costs per 1 kg of weight gain	732.47		794.98		-85.11

As a positive point, we can highlight the reduction of costs for animal protection products by 11.9% due to their rational use; for feed by 1 016.9 thousand tenge or 44.2%.

The efficiency of meat production in modern conditions is determined by the average daily gain, if we compare the average daily gain on average by technology, then after the introduction of digital technologies it is 1 344 grams per day a day, and before the introduction of 1 030 grams, which is 314 grams lower (таble 6).

Table 6 - Economic indicators before and after the introduction of new technologies in the economy

Indicator	Before implementation	After implementation	Change
Average daily weight gain, grams	1 030	1 344	314
Average weight of one head sold for slaughter (w.v.), kg	391	347	-44
Production cost of 1 ts, tenge	73 247	79 498	6 251
Cost of 1 ts of products sold, tenge	87 897	95 398	7 501
Sale price of 1 ts, tenge (including VAT)	135 714	170 000	34 286
Profit from the sale of 1 ts, tenge	47 818	74 602	26 785

The profitability of production in «Novobratskoye» LLP is up to 54.4%, then after the introduction of 78.2%, which exceeds by 24%, the payback of the project within 6 months (table 7).

Table 7 - Comparative economic assessment of the effectiveness of the introduction of new equipment

Indicator	Before implementation	After implementation
The cost of investment in equipment, thousand tenge	-	45 590.42
Costs per 1 head of weight gain, thousand tenge	732.47	794.98
Average daily weight gain, grams	1 030	1 344
Average labor productivity, kg/person	1 509.3	2 024.2
Return on investment, months	-	0.6
Profitability, %	54.4	78.2

The cost of 1 head of weight gain after the introduction of the «Intergado» system amounted to 794.98 thousand tenge (average daily weight gain of 1 344 grams) in comparison with the traditional system, there is an increase of 62.51 thousand tenge due to under-feeding of animals, as evidenced by the average daily weight gain (1 030 grams). The average labor productivity before the introduction was 1 509.3 kg / person, then after the introduction there is an increase to 2 024.2 kg / person, which affects the high profitability results for meat products.

Conclusion. The dissemination of proven, confirmed by practical experiments, product information is an important condition affecting the degree of their penetration into practice; the implementation of incomplete or insufficiently substantiated technological solutions can lead to significant losses for producers in animal husbandry [15]. Thus, the introduction of the «Intergado» system has a number of advantages:

1. It will allow real-time monitoring of the herd and evaluation of bulls based on data such as animal weight, average daily gain and residual feed consumption.

2. Moreover, these data will allow identifying the best bulls and conducting breeding selection, thereby helping to increase both productivity and efficiency of cattle meat production.

3. The temperament of bulls can serve as an important criterion for breeding selection in order to breed calmer bulls. Bulls with a calm temperament exhibit favorable meat characteristics and achieve faster live weight gains, ultimately resulting in increased profitability for farms dedicated to beef cattle breeding.

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