IRSTI 06.71.07
UDC 338.43 (045)
DOI: 10.46666/2022-4.2708-9991.12 https://www.jpra-kazniiapk.kz

THE USE OF GPS TRACKERS IN HERD HORSE BREEDING: JUSTIFICATION OF PRODUCTION INDICATORS

ЖЫЛҚЫ ШАРУАШЫЛЫҒЫНДА GPS ТРЕКЕРЛЕРІН ҚОЛДАНУ: ӨНДІРІСТІК КӨРСЕТКІШТЕРДІҢ НЕГІЗДЕМЕСІ

ПРИМЕНЕНИЕ GPS ТРЕКЕРОВ В ТАБУННОМ КОНЕВОДСТВЕ: ОБОСНОВАНИЕ ПРОИЗВОДСТВЕННЫХ ПОКАЗАТЕЛЕЙ

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Abstract. At present, GPS search technologies are increasingly being used to track cows, horses, sheep and other animals in vast pastures. Comfortable monitoring of the movement of animals is one of the primary tasks set by the owners of cattle and horses. So-called GPS collars are common on large farms, as well as in small private households, and are one of the important solutions to the problem of cattle theft prevention. *The goal* – is to substantiate the use of GPS trackers and effectiveness of monitoring of the state of herd horse breeding in the areas where basic farms are located. In order to assess economic feasibility of "smart" animal husbandry technology, the following methods were applied: review of scientific literature on relevant topics; questioning. The article discusses main directions of digitalization in horse breeding: determining the location of animal in real time, its physical activity, shows innovative approaches that have manifested themselves in the presence of new investment objects (GPS trackers, computer programs, databases), emergence of new effects. The authors studied and analyzed the data on disposal of livestock of horses for reasons not related to production activities, and also calculated the amount of losses. A practical example of the use of GPS trackers is presented and their economic benefits are proven. *The results* of the study indicate the need for a wider introduction of information and digital systems that allow to maximize the speed of obtaining information on location and prevent the loss of animals of non-productive nature (theft). *Conclusions* – this device monitors, fixes and analyzes the activity of the observed object in real time, often GPS tracker for horses can save the animal's life or save the owner from significant damage.

Аннотации. Қазіргі уақытта кең жайылымдарда сиырларды, жылқыларды, қойларды және басқа малдарды бақылау үшін жаһандық GPS іздеу позициялау жүйесінің технологиялары көбірек қолданылуда. Малдардың қозғалысын ыңғайлы бақылау - бұл ірі қара мен жылқы иелері алдына қоятын басты міндеттердің бірі. GPS деп аталатын ноқталар ірі фермаларда, сондай-ақ шағын жеке шаруашылықтарда кең таралған және малды ұрлаудың (ұрлаудың) алдын алудың маңызды шешімдерінің бірі болып табылады. *Мақсаты* – GPS

трекерлерін пайдалануды негіздеу және олардың базалық шаруашылықтар орналасқан аудандардағы жылқы шаруашылығының жай-күйін бақылау тиімділігі. "Ақылды" мал шаруашылығы технологиясының экономикалық орындылығын бағалау мақсатында: тиісті тақырып бойынша ғылыми әдебиеттерге шолу жасау; сауалнама жүргізу әдістері қолданылды. Мақалада жылқы шаруашылығындағы цифрландырудың негізгі бағыттары қарастырылған: малдың нақты уақыт режимінде орналасуын, оның қозғалыс белсенділігін анықтау, жаңа инвестициялық объектілердің (GPS трекерлері, компьютерлік бағдарламалар, мәліметтер базасы), жаңа әсерлердің пайда болуында көрінетін инновациялық тәсілдер көрсетілген. Авторлар өндірістік қызметпен байланысты емес себептер бойынша жылқы басының шығу деректерін зерттеді және талдады, сондай-ақ шығындар сомасы есептелген. GPS трекерлерін қолданудың практикалық мысалы келтірілген және олардың экономикалық пайдасы дәлелденген. Зерттеу нәтижелері орналасқан жері бойынша ақпарат алуды барынша жеделдетуге және өндірістік емес сипаттағы малдардың (ұрлық, айдап әкету) жоғалуын болдырмауға мүмкіндік беретін ақпараттық-цифрлық жүйелерді неғұрлым кеңірек енгізу қажеттігін көрсетеді. *Қорытындылар* - бұл құрылғы нақты уақыт режимінде бақыланатын объектінің қызметін бақылайды, тіркейді және талдайды, көбінесе жылқыларға арналған GPS трекері малдың өмірін сақтап қалуы немесе иесіне айтарлықтай зиян келтірмеуі мүмкін.

Аннотации. В настоящее время для отслеживания коров, лошадей, овец и других животных на обширных пастбищах все чаще применяются технологии Глобальной системы позиционирования GPS поиска. Комфортное наблюдение за перемещением животных – одна из первостепенных задач, которую ставят перед собой владельцы КРС и лошадей. Так называемые GPS-ошейники распространены на крупных фермах, а также в небольших частных хозяйствах и являются одним из важных решений проблемы предотвращения угона (кражи) скота. *Цель* – обоснование использования GPS трекеров и эффективность их наблюдения за состоянием табунного коневодства в районах размещения базовых хозяйств. С целью оценки экономической целесообразности технологии «умного» животноводства применены *методы*: обзор научной литературы по соответствующей тематике; анкетирование. В статье рассмотрены основные направления цифровизации в коневодстве: определение местоположения животного в режиме реального времени, его двигательной активности, показаны инновационные подходы, проявившиеся в наличии новых объектов инвестирования (GPS трекеры, компьютерные программы, базы данных), появлении новых эффектов. Авторами изучены и проанализированы данные выбытия поголовья лошадей по причинам, не связанным с производственной деятельностью, а также рассчитана сумма потерь. Представлен практический пример применения GPS трекеров и доказана их экономическая выгода. *Результаты* исследования свидетельствуют о необходимости более широкого внедрения информационно-цифровых систем, позволяющих максимально ускорить получение информации по местоположению и предотвращать потерю животных непроизводственного характера (кража, угон). *Выводы* – данное устройство в режиме реального времени контролирует, фиксирует и анализирует деятельность наблюдаемого объекта, зачастую GPS трекер для лошадей может спасти животному жизнь или уберечь хозяина от значительного ущерба.

Key words: agriculture, herd horse breeding, horse stock, slaughter, average live weight, sales, digital technologies, GPS trackers, efficiency.

Түйінді сөздер: ауыл шаруашылығы, табынды жылқы шаруашылығы, жылқы басы, сою, орташа тірі салмақ, өткізу, цифрлық технологиялар, GPS трекерлері, тиімділік.

Ключевые слова: сельское хозяйство, табунное коневодство, поголовье лошадей, забой, средний живой вес, реализация, цифровые технологии, GPS трекеры, эффективность.

Introduction. Among the priority directions of development of the agricultural sector of Kazakhstan, the solution for the problem of increasing the production of meat and its processed products seems timely and relevant. With the presence of vast territories of natural pastures (180 million hectares) the Republic of Kazakhstan has significant prospects in supplying the country with environmentally friendly food. A large reserve for the implementation of the Food Program of the republic is transhumance, in particular, horse breeding [1].

After all, the cheapest source of keeping herd horses is their year-round maintenance on pastures. In Kazakhstan horse breeding is a specific traditional industry. Horse meat products – meat, koumiss, delicatessen products: kazy, zhal, zhaya, karta are in great de-

mand among the population, that is, herd horse breeding is a profitable industry for the economy and industry of our country [2,3]. But recently, the problem of horse theft and theft has become acute - the solution of which we see in the use of digital technologies.

Horse breeding is a difficult and rather expensive branch of animal husbandry. It is not easy to save and grow a herd on free grazing. Farmers face a number of adverse factors: difficulty in determining the current location of the herd; death of animals; theft; complex record of quantity [lk.3].

The way out of the situation is satellite positioning systems – GPS trackers, which are in the real-time tracking of the location of a given object. It has become an actual and in-demand service for a wide range of service consumers [4,5].

Therefore, the issue of the effectiveness of the introduction of digital technologies is relevant (GPS trackers), which will minimize the impact of the human factor and solve the problem of remoteness and loss of livestock.

Material and methods of research. The theoretical and methodological basis of the research in the article was the scientific works of domestic and foreign specialists and scientists in the field of theory and practice on the analysis of the horse breeding industry of economic entities. Information materials were used, including from the websites of the Ministry of Agriculture of the Republic of Kazakhstan, the Ministry of Statistics Department, domestic organizations, where research results and information on the digitalization of agriculture are presented, on the basis of which their analysis and generalization are carried out.

The article reveals the objective socio – economic necessity of the development of herd horse breeding in the areas where the basic farms are located. An economic assessment of the development of herd horse breeding is given; the number of horses in the dynamics over years is considered and analyzed; provides information on the losses of horses associated with non-productive activity of farms (theft, theft); provides information on prices for processing products.

Calculations for the acquisition and further operation of GPS trackers, justifications for their use, which provide new opportunities for analyzing animal tracking, represented by interests, location, geographical data, are given.

The authors confirm that Global Positioning System (GPS) trackers, which provide the necessary information about the location and movement of horses, can serve as an important factor in the safety and growth of the number of horses.

Results and their discussion. The data of the official statistics of the Republic of Kazakhstan allow us to state that, in general, the total number of horses in the areas of the basic farms increased by 1.1-1.5 times from 2016 to 2021 (table 1).

Table 1 - The number of horses in the areas of the basic farms for 2016-2021 (on January, 1)

№	Indicator	Number of horses, heads					
		2016	2017	2018	2019	2020	2021
1.	East Kazakhstan region, Tarbagatai district						
1.1.	Total (all categories of farms)	23 353	26 114	29 439	33 448	36 040	40 776
1.1.1	Agricultural enterprises	605	690	680	750	716	858
1.1.2	Peasant or farm households	14 020	16 198	19 006	21 964	23 017	25 823
1.1.3	Households of the population	8 728	9 226	9 753	10 734	12 307	14 095
2.	Zhambylregion, Bayzak district						
2.1.	Total (all categories of farms)	10 585	11 179	12 632	13 414	14 765	17 113
2.1.1	Agricultural enterprises	105	-	19	-	-	-
2.1.2	Peasant or farm households	5 210	5 769	6 841	7 639	8 425	10 041
2.1.3	Households of the population	5 270	5 410	5 772	5 775	6 340	7 072
3.	Zhambylregion, Zhualy district						
3.1.	Total (all categories of farms)	8 520	8 780	9 920	10 366	13 132	14 080
3.1.1	Agricultural enterprises	51	61	61	61	70	66
3.1.2	Peasant or farm households	3 681	3 974	4 638	5 208	5 220	4 573
3.1.3	Households of the population	4 788	4 745	5 221	5 097	7 842	9 441
4.	Pavlodarregion, Maysky district						
4.1.	Total (all categories of farms)	15 000	15 400	15 900	20 100	20 121	26 107
4.1.1	Agricultural enterprises	3 000	3 400	3 200	4 800	4 754	6 246
4.1.2	Peasant or farm households	6 000	6 500	7 400	10 100	9 235	11 558
4.1.3	Households of the population	6 000	5 500	5 200	5 200	6 132	8 303

5.	Akmolaregion, Tselinograd district						
5.1.	Total (all categories of farms)	15 300	16 900	18 200	19 000	19 089	18 761
5.1.1	Agricultural enterprises	3 100	3 500	3 800	4 000	3 346	3 659
5.1.2	Peasant or farm households	2 000	2 200	2 900	2 900	3 336	3 124
5.1.3	Households of the population	10 300	11 200	11 500	12 200	12 407	11 978
6.	Almatyregion, Panfilovsky district						
6.1.	Total (all categories of farms)	18 351	17 927	18 450	18 558	19 880	20 659
6.1.1	Agricultural enterprises	723	869	912	487	564	524
6.1.2	Peasant or farm households	11 202	10 457	11 023	11 422	12 438	12 890
6.1.3	Households of the population	6 426	6 601	6 515	6 649	6 878	7 245
Note: according to the data of the regional departments of agriculture.							

According to the table, the largest increase in the number of horses by 1.5 times is observed in the Tarbagatai district of East Kazakhstan region and Zhualy district of Zhambyl region. This is due to favorable climatic and historical conditions. The increase in livestock by 1.3 times was noted in the Bayzak district of the Zhambyl region and the Maysky district of the Pavlodar region. In addition, a relatively small increase in herds is observed in the Tselinograd district of the Akmola region and the Panfilov district of the Almaty region. At the same time, the largest share of livestock is concentrated in peasant farms or farms of the population of the analyzed areas.

Thus, the share of these farms in Tarbagatai district accounts for 98%, Baizak, Zhualy districts – almost 100%, Maysky district - 76%, Tselinograd district – 81% and Panfilovsky – 98% of the total livestock of the district. Thus, the growth of livestock in the district is mainly provided by these forms of management, which, as experience shows, are favorable for herd horse breeding.

Horses are kept on pastures. The area of pastures in the presence of each of the farms ranges from 500 hectares to 93 360 hectares [6]. Basic farms keep records mainly on paper. The weight of horses is not taken into account since most of the time the animals are on pastures. Basically, accounting is carried out only in quantitative terms in the context of gender and age groups. Therefore, the collection of information about the qualitative characteristics of farms was carried out through interviews.

It is established that in all basicfarms there is an increase in the number of horses. At the same time, in two farms, the growth of livestock significantly exceeded the average for the corresponding area (3.7 times and 2.6 times). The remaining farms increased their livestock in an amount slightly inferior to the average rate of increase in livestock in the district. The selling price of horse breeding products is set individually within each individual transaction. In general, according to farms, it corresponds to the average price for the district, reflected in official statistics [7]. Therefore, for the purposes of this study, the average selling price of horse breeding products in 2021 was adopted on the basis of official statistical information (table 2).

Table 2 - Prices for agricultural products, products of its processing (horses) by districts for 2016-2021, per head (on January, 1)

Indicator	Price, tenge					
	2016	2017	2018	2019	2020	2021
East Kazakhstan region, Tarbagatai district						
Horses from 3 years and older	244 545	290 000	290 000	299 126	337 461	400 000
Young horses up to 3 years old	197 000	200 000	200 000	200 000	240 617	320 000
Foals up to 1.5 years old	118 027	132 810	154 927	160 000	189 712	230 000
Horse meat, per kilogram	1 200	1 470	1 500	1 577	1 900	-
Zhamby lregion, Baizak district						
Horses from 3 years and older	320 100	370 000	390 000	399 666	442 731	498 328
Young horses up to 3 years old	230 400	280 000	256 360	300 000	289 104	326 013
Foals up to 1.5 years old	120 700	175 000	179 256	220 000	207 457	219 392
Horse meat, per kilogram	1 400	1 558	1 600	1 806	1 558	2 100
Zhambyl region, Zhualy district						
Horses from 3 years and older	325 110	364 904	383 536	405 382	442 731	498 328
Young horses up to 3 years old	238 441	280 000	272 265	256 360	289 106	326 013
Foals up to 1.5 years old	123 709	167 067	191 824	179 526	207 457	219 392
Horse meat, per kilogram	1 300	1 363	1 528	1 728	1 991	2 100

Pavlodar region, Maysky district						
Horses from 3 years and older	271 064	300 000	300 000	320 000	336 528	410 000
Young horses up to 3 years old	200 000	200 000	200 000	250 000	277 084	340 000
Foals up to 1.5 years old	147 701	120 000	122 459	150 000	183 189	200 000
Horse meat, per kilogram	1200	1 522	1 606	1 747	2 000	2 000
Akmola region, Tselinograd district						
Horses from 3 years and older	350 000	372 632	412 614	426 417	468 230	480 000
Young horses up to 3 years old	280 000	282 603	316 327	324 815	360 207	375 000
Foals up to 1.5 years old	111 607	141 710	165 927	174 668	208 102	220 000
Horse meat, per kilogram	1 449	1 591	1 600	1 950	2 496	2 600
Note: a source: https://stat.gov.kz						

According to the table, the following conclusions can be drawn:

● in the East Kazakhstan region: (i) for horses aged three years and older - 400.0 thousand tenge per head (+38% compared to 2018); (ii) for young animals up to three years – 320.0 thousand tenge (+60% compared to 2018); (iii) for foals up to 1.5 years – from 154.9 to 230.0 thousand tenge, depending on individual characteristics (+48% compared to 2018). The average selling price of horse meat was 2 100 tenge per kilogram, which is 900 tenge (75%) more expensive than in 2016;

● in Zhambyl region: (i) for horses aged three years and older – 498.3 thousand tenge per head (+30% compared to 2018); (ii) for young animals up to three years – 326.0 thousand tenge (+20% compared to 2018); (iii) for foals up to 1.5 years – 219.4 thousand tenge (+14% compared to 2018). The average selling price of horse meat was 2 100 tenge per kilogram, or 37% more expensive than in 2018.

According to official statistical information, the average weight of a horse at slaughter varied from 332 to 350 kg [lk.7]. According to the farms, these values reflect the indicators of their activity, so they were adopted as the basis for the study (table 3).

Table 3 - Average live weight of a horse slaughtered on farms or sold for slaughter in 2016-2021

Region	Average live weight of a horse at slaughter, kg					
	2016	2017	2018	2019	2020	2021
Akmola region	336	337	333	330	329	327
EastKazakhstan region	324	327	332	334	337	338
Zhambyl region	341	340	352	353	355	359
Pavlodar region	338	339	339	339	337	342
Note: based on official statistical information, www.stat.gov.kz [lk.7].						

The average number of employees engaged in grazing of horses is from one to three people. The average monthly salary ranges from 80.0 to 150.0 thousand tenge per month. Additionally, at the end of the year, up to two heads of horses are transferred to each employee as a reward for work.

It was found that the attrition of livestock in 2018-2022 for reasons unrelated to production ranged from 1.1% to 6.5% per year, and on average at the level of 3.0%, but it is permanent, unforeseen and entails significant financial losses (table 4).

Table 4 - Attrition of the number of horses in the basic farms for reasons unrelated to production activities for 2017-2022 (on January, 1)

Farm	Livestock attrition (% of total livestock, damage in thousands of tenge)											
	2017		2018		2019		2020		2021		2022	Total
	%	damage	%	damage	%	damage	%	damage	%	damage	damage	damage
Farm 1	-	-	-	-	-	-	-	-	2,8	1 583,8	-	1 583,8
Farm 4	3,1	550,0	1,1	275,2	6,3	2 145,9	1,3	626,2	3	1 739,5	-	5 336,8
Farm 5	3,8	406,7	4,4	640,0	4,1	878,8	3,6	1 535,6	3,5	2 217,4	-	5 678,5
Farm 7	3,1	825,0	1,9	606,7	5,2	1 839,3	3,5	1 252,4	2,5	1 043,7	-	5 567,1
Farm 8	1,1	630,0	1,1	655,2	1,2	728,9	1,3	751,2	3,9	2 899,6	-	5 664,9
Farm 10	-	-	-	-	-	-	-	-	2,1	633,5	-	633,5
Total, thousand tenge		2 411,7	-	2 177,1	-	5 592,9	-	4 165,4	-	10117,5	-	24 464,6
Note: according to the data provided by the basic farms in the form of documents or as a result of interviews; the damage is calculated at the average selling prices of horses in the relevant area.												

The average amount of damage per household increased from 402 thousand tenge in 2018 to 1 686.3 thousand tenge in 2021, or by 70.7%. Taking into account the correction for the increase in the price of one horse for the same period by an average of 40%, the increase in damage, excluding the inflation factor, will be about 60% to the level of 2018 in 2022, theft, loss of non-productive nature was not observed. As a result, the risks of livestock loss are assessed by the heads of farms as high, and the prospect of gaining access to technologies that allow remote monitoring of the location of animals, provided their economic efficiency.

According to farms, the main reasons for the disposal of livestock are theft and attacks of wild animals. As the heads of several farms noted, their resources can significantly increase the number of horses and, as a result, the production of products. However, the risks of disposal of animals for the above reasons and the lack of available means of livestock control are the main deterrent to further increase in production both in the farms themselves and in the areas of their location as a whole [8,9].

In addition to direct damage from the disposal of livestock, the lack of operational control over the finding of animals entails additional costs associated with their search. According to the information of the basic farms, as a rule, the search for animals is carried out within a radius of up to 100 km from the location of the herd and can take up to several days. Depending on the number of lost horses, 2-3 cross-country vehicles participate in the search (as a rule, cars of the brand "Niva" or "UAZ", or foreign cars with a service life of more than 15 years). Accordingly, significant human resources are diverted, unforeseen costs for fuel and lubricants, fuel, and car maintenance arise.

Additionally, the heads of farms of the Zhambyl region noted the peculiarity of being in the border zone. Thus, cases of horse theft are mainly associated with theft to the Republic of Kyrgyzstan. Having tested 10 stallions that drive 50-60 heads, it turns out that 600 heads on average will be under control, and based on this, this technology justifies itself twice, providing security around the clock, and the cost of 1 tracker is on average 120.0 – 150.0 thousand tenge, plus a subscription fee of 100.0 thousand tenge per month.

Based on the above, the following formula is proposed to determine the effect of the introduction of trackers in herd horse breeding in the prices of 2021:

$$Э_{тр} = (В \times Ц + \text{Search costs} \times И) - \left(\text{average cost of the tracker} \times \frac{П}{К} + \text{maintenance costs}\right),$$

where: $Э_{тр}$ – the effect of the introduction of trackers;

В – average number of retired animals;

Ц – the average selling price of an animal per year for which the effect is calculated;

И – the average number of incidents per year related to the loss of animals, calculated on the basis of data for several previous years;

П – total number of livestock animals;

К – average number of animals in one shoal.

A positive value of the variable indicates that there is an effect from the use of trackers (that is, the amount of possible damage exceeds the cost of installing and maintaining trackers):

- based on the proposed formula, the magnitude of the effect is influenced by (1) the sale price of animals prevailing on the market;
- the cost of purchasing and servicing trackers;
- the total number of livestock;
- the number of incidents related to the disposal of livestock, and;
- (the number of animals that have been disposed of. It should be noted that when calculating for variables B and I, it is recommended to use the average values for several previous years due to the significant variation of the retired livestock by year.

The use of the formula for other periods is possible by recalculating its fixed parameters based on their ratio to the sale price of one animal, given in this article. The formula proposed by the authors can serve as one of the tools for preliminary assessment of the potential effect when farms consider the use of trackers in each individual case. Along with the formula, the factors given in this article that affect the magnitude of the effect, and the established ratios between the costs of implementing trackers and the price of selling animals, will significantly increase the efficiency of planning and resource use in herd horse breeding. Therefore, the responsiveness to the loss of horses significantly affects the prospects for their return (the loss was discovered faster, the chances of returning the animals are greater).

Conclusion. Comfortable observation of the movement of animals is one of the primary tasks set by the owners of cattle and horses. Therefore, the solution to this problem lies in the hypothesis of the use of so-called GPS collars:

1. The use of such gadgets is completely safe for animals. Most models do not require special skills. Beacons use satellite communication for work, and therefore can be operated even where cellular communication does not have stable reception.

2. A wide range of operating temperatures allows the use of new technologies in deserts, steppes, mountains and forests.

3. The tracker has sensors of horizontal and vertical position - the owner of the animal receives information not only about the location of the horse, but also about the position of the artiodactyl [10].

Thus, the use of remote monitoring systems for the location of animals makes it possible to reduce the disposal of livestock as a result of theft, injury, attacks by wild animals, and other factors unrelated to production activities, thereby saving time and money.

An expression of gratitude. The authors express their gratitude to the team of the research project "Development and creation of scientifically-based Smart farms (horse breeding, beef cattle breeding) with the use of at least 3 digital solutions for each area of digitalization implementation for the actual production tasks of agro-industrial entities and the formation of the necessary reference database for training employees of farms and peasant farms and transfer of digital knowledge to students" for assistance in collecting information and data on horse breeding. The study was funded by the Ministry of Agriculture of the Republic of Kazakhstan (BR10865103).

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