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## CAUSES OF DEGRADATION OF NATURAL PASTURES IN THE ZHAMBYL REGION AND THEIR RESTORATION

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*The article presents data obtained during study conducted in the context of the vertical (altitudinal) zonation of soils in the southeastern part of Kazakhstan, aimed at studying the causes of pasture degradation. The technologies for their restoration in specific project areas are also outlined.*

*Natural forage lands are the basis of nutrition for animal husbandry. A study of the current state of the food supply in our country shows that up to 80% of the animal feed ration is pasture forage. More than 64% of the area of Kazakhstan is occupied by pasture lands. Pasture forage is a plant resource that is renewed annually, and its potential productivity is about 22-26 million tons of feed units. Nevertheless, it should be noted that the consumer attitude of users to these natural resources has a negative impact on their nutritional value. Yields decrease, the composition of the grass layer and the quality of the forage change, and the areas become overgrown with inedible and poisonous plants.*

*During the study, water and physical parameters of the soil, agrochemical analysis of the soil, measurement of the projective cover of plants and weighing of the pasture mass of grass, determination of the forage nutritional value (chemical composition) were carried out. Taking into account the seasonal yield of natural grass, the increase in live weight of animals during the grazing period and economic efficiency were determined. In the course of the ongoing work, conditions have being created for the restoration of degraded pastures in the Zhambyl region. The growth and development of the green cover increases by 14-17%, and livestock production rises by 11% due to rational grazing practices.*

***Key words:*** *degradation, rotation, vertical (altitudinal) zonation, natural zone, soil moisture, yield, animals.*

## ЖАМБЫЛ ОБЛЫСЫНДАҒЫ ТАБИҒИ ЖАЙЫЛЫМДАРДЫҢ ТОЗУ СЕБЕПТЕРІ ЖӘНЕ ОЛАРДЫ ҚАЛПЫНА КЕЛТІРУ

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*Мақалада жайылымдардың тозу себептерін зерттеу мақсатында Қазақстанның оңтүстік-шығыс бөлігіндегі топырақтың тік (биіктік) аймақтылығы жағдайында зерттеу барысында алынған деректер көрсетілген. Оларды белгілі бір жобалық аумақтарда қалпына келтіру технологиялары келтірілген. Табиғи жемшөп алқаптары мал шаруашылығы үшін азық-түліктің негізі болып табылады. Біздің еліміздегі жем-шөп базасының қазіргі жай-күйін зерттеу көрсеткендей, жануарлардың жем-шөп рационының 80 %-ы жайылымдық жемге тиесілі. Қазақстан аумағының 64 %-дан астамын жайылымдық жерлер алып жатыр. Жайылымдық жем-бұл жыл сайын жаңартылатын өсімдік қоры және оның өнімділігі шамамен 22-26 миллион тонна жем бірлігін құрайды. Дегенмен, пайдаланушылардың осы табиғи ресурстарға тұтынушылық қатынасы олардың тағамдық құндылығына теріс әсер ететінін атап өткен жөн. Өнімділік төмендейді, шөптің құрамы мен жем сапасы өзгереді, ал аумақтар жеуге жарамсыз және улы өсімдіктермен толып кетеді.*

*Зерттеу барысында топырақтың су-физикалық көрсеткіштері, топырақтың агрохимиялық талдауы, өсімдіктердің проективті жабынын өлшеу және шөптің жайылымдық массасын өлшеу, жемшөптің тағамдық құндылығын анықтау (химиялық құрамы) жүргізілді. Табиғи шөптің маусымдық өнімділігін ескере отырып, жайылым кезеңінде жануарлардың тірі салмағының өсуі және экономикалық тиімділігі анықталды. Жүргізіліп жатқан жұмыстарды орындау барысында Жамбыл облысының тозған жайылымдарын қалпына келтіру үшін жағдайлар жасалады, өсімдік жамылғысының өсуі мен дамуы 14-17%-ға дейін ұлғаяды, мал шаруашылығы өнімін ұтымды жаю есебінен өндіру 11%-ға ұлғаяды.*

***Түйінді сөздер:*** *тозу, айналым, тік (биіктік) аймақтылық, табиғи аймақ, топырақтың ылғалдылығы, өнімділік, жануарлар.*

## ПРИЧИНЫ ДЕГРАДАЦИИ ЕСТЕСТВЕННЫХ ПАСТБИЩ В ЖАМБЫЛСКОЙ ОБЛАСТИ И ИХ ВОССТАНОВЛЕНИЕ

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*В статье показаны данные, которые были получены в ходе исследования в условиях вертикальной (высотной) зональности почв юго-восточной части Казахстана с целью изучения причин деградации пастбищ. Приведены технологии их восстановления на определенных проектных территориях. Природные кормовые угодья являются основой питания для животноводства. Изучение текущего состояния кормовой базы в нашей стране показывает, что до 80 % кормового рациона животных приходится на пастбищные корма. Более 64 % площади Казахстана занимают пастбищные угодья. Пастбищные корма – это растительный ресурс, который ежегодно возобновляется, и его потенциальная продуктивность составляет около 22-26 миллионов тонн кормовых единиц. Тем не менее, необходимо отметить, что потребительское отношение пользователей к этим природным ресурсам оказывает отрицательное влияние на их пищевую ценность. Урожайность снижается, состав травостоя и качество корма изменяются, а территории зарастают несъедобными и ядовитыми растениями.*

*В ходе исследования были проведены водно-физические показатели почвы, агрохимический анализ почвы, измерение проективного покрытия растений и взвешивание пастбищной массы травостоя, определение питательной ценности кормов (химический состав). Принимая во внимание урожайность естественного травостоя по сезонам, определено прирост живой массы животных за период выпаса и экономическая эффективность. В ходе выполнения проводимых работ создаются условия для восстановления деградированных пастбищ Жамбылской области, рост и развитие растительного покрова увеличивается до 14-17%, производство животноводческой продукции за счет рационального выпаса увеличивается на 11%.*

***Ключевые слова:*** *деградация, ротация, вертикальная (высотная) зональность, природная зона, влажность почвы, урожайность, животные.*

**Introduction.** The Republic of Kazakhstan is located in the center of the Eurasian continent at the junction of two continents, its area is 272. 5 million hectares. Part of the territory of the Republic is located in Europe, the main part is in Asia. In terms of land area, Kazakhstan is one of the ten largest countries in the world, and in terms of land supply per capita, it ranks third in the world after Australia and Canada. Natural pastures are publicly owned as one of the categories of agricultural land, which means a type of agricultural land used as pasture for purposes such as cattle grazing. Since pastures are one of the main national resources of the country, ensuring rational use and protection is the most important national task. According to the cultural and technical condition, 109. 4 million hectares (61. 4%) of pastures are unadulterated. 5. 5 million hectares (3. 1%) improved, 19. 0 million hectares overgrown with shrubs (10. 6%), 1. 6 million hectares covered with tussock (0. 9%), 3. 2 million hectares – filled (1. 8%), 4. 7 million hectares – (2. 6%) stony, 7. 7 million hectares – (4. 3%) overgrown areas, 27. 1 million hectares (15. 1%) – downed lands. Of the 183. 4 million hectares of pasture land available, only 43.8 % or 80. 0 million hectares are used for grazing. Basically, the livestock of all types of animals is kept in territories located near settlements, and these land plots are currently being degraded, because 20, 0 million heads of all types of animals of private farmsteads and peasant farms are grazed on these areas. It can be seen from this that due to the irrational use and violation of traditional grazing rules, especially near populated areas, pasture users are experiencing a shortage of pastures and, accordingly, the load on the unit area of grazing of farm animals increases. All these processes occur due to existing legal barriers, namely the imperfection of the legislative framework regarding the strengthening, distribution and use of pasture resources [1, 2].

The Zhambyl region is naturally and climatically located in the desert zone of the temperate zone, characterized by low precipitation, high evaporation and significant daily and annual temperature fluctuations. The main climatic feature is aridity, which directly determines the uniqueness of the landscape of the region [3].

Overrun of pastures is the main consequence of changing environmental conditions and irrational human economic activities. It manifests itself in the loss of valuable forage plant species from the grass stand and their replacement by weeds, inedible and annual species. Depending on the nature of the failure, pasture lands are divided into three categories: 1 – with secondary vegetation (67% of all downed pastures), 2 – littered with inedible and poisonous plants, 3 – trails, potholes, cattle driving. The third category of downed pastures includes areas with a lack of vegetation cover and livestock destruction (temporary grazing inconvenience). This is the extreme stage of failure, which was detected on an area of 0.8 million hectares or 3%. Their largest areas are noted in Zhambyl and Almaty regions (240 and 172.4 thousand hectares, respectively) [4].

The purpose of the research was to study the causes of degradation of natural pastures in Zhambyl region and their restoration.

To achieve this goal, the following tasks are set: water and physical parameters of the soil, agrochemical analysis of the soil, measurement of the projective cover of plants and weighing of the pasture mass of grass, determination of the forage nutritional value (chemical composition) were carried out. Taking into account the seasonal yield of natural grass, the increase in live weight of animals during the grazing period and economic efficiency were determined.

**Research methods.** The development presented by us is a fundamentally new direction for the restoration of land resources that have undergone negative changes from anthropogenic impact. The studies were carried out in 2015-2017 according to the following scheme [5]. List of completed work on accounting and observations:

1. Determination of the soil water-physical indicators

Reserves of productive moisture were determined by thermostatic-weight method. Soil samples used to determine moisture in the field were taken using a special drill, immersing it in the soil to a predetermined depth. The soil samples were selected from each 10 cm of soil layer, then placed in a pre-weighed aluminum cups. In the laboratory, it was weighed on electronic scales with an accuracy of 0.01 g. Then the cups with soil were placed in a drying cabinet and dried to a constant mass at a temperature of 105 °C. Determination of the volume mass of soil was carried out on 4 fixed plots, in layers of 10 cm to the depth of 50 cm [6]. Determination the soil moisture reserves in 4 points, by drilling up to 0. 5 m in 10 cm by thermostatic-weight method according to seasons: spring, summer and autumn in triplicate; determination of green mass yield on specific plots of 10 $m^2$ plant outlines for the grazing period [7, 8].

The agrochemical soil analysis included: cation-anionic composition of aqueous extract [9], content of humus – by Tyurin [10], content of mobile mineral forms of phosphorus and potassium -in carbon ammonium extract by Machigin (Central Institute of Agricultural Chemical Services) [11], content of nitrates' nitrogen – by ionometric method [12].

2. Measuring the projective cover of plants and weighing the pasture mass of herbage

For each plot, the design coverage is calculated by applying a ‘Ramenskij grid’ to the grass and by calculating the percentage of filled cells. Determination of the pasture mass was carried out by the Method of accounting for the harvest of yield hayfields and pastures in stationary experiments [13]. Mowing of grass was carried out in a continuous way with a mower which harvesting width was 2.1 m and height – 6-7 cm. Drying, weighing of mowed grass was carried out directly on the sites (10 $m^2$).

3. Determination of nutritional value of feed

Determination of the chemical composition of feed by seasons was determined in the laboratory of the “Kazakh Scientific Research Institute of Animal Breeding and Forage Production”. That included the definition of content of moisture, crude protein, fat, ash, fiber, phosphorus, calcium, as well as digestible protein, metabolic energy and feed units.

4. Determination of the increase in animals' live weight

Measurement of live weight gain of animals was carried out weighing selected animals in control and experimental groups.

The gain of live weight of animals was established by weighing of the 10 sheep from different age groups in the spring and in the autumn. The value of the relativity of mass gain (growth intensity) was calculated by the Schmalhausen and Brody method [14].

5. To conduct a statistical analysis of the experimental data, the methods of the Dospekhov variance analysis [15] were used using the SNEDECOR program. To calculate the average values and standard errors, the ANOVA software in Microsoft Excel was used, and the significance of probabilities was estimated using the Student t-test number [16].

**Discussion and results**. Zhambyl region is located in the south of the Republic of Kazakhstan, the area of which is 144. 3 thousand square $km^2$ or 5. 3% of the territory of the Republic and is located in the southeastern part of Kazakhstan, bordered on the west and east by Turkestan and Almaty regions, on the north by Karaganda, on the south by the Kyrgyz Republic. There are 10 districts in the structure of the region, a city of regional subordination – Taraz and 3 cities of regional subordination – Karatau, Zhanatas, Shu. 153 rural districts, 367 rural settlements. Zhambyl region is located at an altitude of 300 to 4. 500 meters above sea level and has a complex relief structure. The northern part is a plain, in the south – the Kyrgyz mountains are the main part of the Talas Alatau range, in the southwest – the Karatau range. In the east there is a fairly extensive lowland massif of the Chu-Ili mountains. Erosion-structural, erosion, Aeolian and accumulative types of relief are widespread in the territory of Zhambyl region. The first and second types are high–altitude areas and disjointed arrays of medium and low mountains. The northern slopes of the ridges, confined to the lines of tectonic disturbances, are steep, strongly dissected, with a sharp bend to the plain, the southern ones are more gentle, belong to the erosion–structural type of relief. The erosion-structural type of relief should include the northern and northwestern slopes of the Kyrgyz, Talas and Karatau ranges. The erosive type of relief is observed in the western spurs of the Trans-Ili Alatau and in the Chu-Ili Mountains; the Aeolian relief dominates in the sandy Muyunkum desert.

Climatic conditions are determined by the geographical location on the plains and the laws of vertical (high-altitude) zonation in the mountains. Climate, one of the most important factors of soil formation and

geographical distribution of soils, is largely determined by cosmic causes (the amount of energy received by the earth's surface from the sun). Climate affects soil formation directly, determining the energy level and hydrothermal regime of soils, and indirectly through other factors of soil formation (vegetation, soil-forming rock, relief). The climate Zhambyl region is characterized by high solar radiation, sharp continentality and severe aridity (plains).

The history of the use of these lands and comparative indicators of their past and present condition were studied in response to questions about the causes of degradation of pastures on the territory of the farm “Batyr” (4. 200 hectares) located in the rural district of Kenen, Kordai district, Zhambyl region. The history of the lands on the territory of the peasant farm under study shows that they were used exclusively as pastures and hay fields. Over the past 50 years, no other anthropogenic impact has been exerted on these lands. To compare the humus content in the upper soil layer (0 – 10 cm), comparative research data from the “Institute of Soil Science and Agrochemistry” and the “Kazakh Scientific Research Institute of Animal Husbandry and Feed Production” LLP are presented (Table 1).

Table 1 – Comparative characteristics of the chemical properties of the soil and the yield of dry matter in the project area (in a layer of 0-10 cm)

| Natural Area | Soil Types | 1963 year | 2012 year | 1963 year | 2012 year |
|---|---|---|---|---|---|
| | | humus, % | | Yield of dry mass, centner/ hectare | |
| Foothill semi desert zone | ordinary grey soil | 1. 30 | 1. 02 | 21. 1 | 5. 6 |
| Foothill dry steppe zone | light chestnut soil | 3. 57 | 3. 04 | 23. 6 | 9. 0 |
| Foothill steppe zone | dark chestnut soil | 4. 52 | 3. 07 | 28. 4 | 14. 7 |

It follows from the table data that the previous period of use of these lands led to a decrease in humus on dark chestnut soils to 32. 1 %; light chestnut soils to 14. 9 %; ordinary gray soils – 21. 6 %. Such changes in soil fertility have affected the yield of forage grasses. So, if in the foothill semi desert zone, the yield of air-dry mass in 1967 reached 21. 1 c/ha, in the foothill-dry steppe zone 23. 6 c/ha and the foothill steppe zone – 28. 4 c/ha, then in 2012 it was 5. 6, 9. 0 and 14. 7 c/ha, respectively.

The law of vertical zonation was formulated by V.V. Dokuchaev based on the study of soil cover: “As one rises from sea level to the tops of high mountains, a number of vertical soil zones are observed, successively replacing one another, as when moving from the equator to the pole”. The structure of vertical zonation is determined by a number of factors, which include: the position of a mountainous country in a system of geographical zones; its position in relation to the ocean, the height of the mountain system. The exposure of slopes, their position relative to the prevailing movement of air masses, and temperature inversions also have a significant impact. In conditions of vertical zonation, the following scheme of pasture resources management for peasant farms is proposed, taking into account differences in pasture types, yield dynamics and nutritional value of pasture feed of the main plant associations, as well as relatively small distances between individual pasture sites. The pasture lands of the project area are located in 3 zones in conditions of vertical zonation, to characterize the soils, we provide soil sections on seasonal pasture plots and on the lands of the settlement (Table 2).

Table 2 – Pasture lands the farm “Batyr”

| Natural Area | Season of using | Coordinates of the cut points | Soil Types | Variant (plant associations) |
|---|---|---|---|---|
| Foothill semi desert zone – 1880 ha | control | N 42°27′34,5″; E 074°53′26,7″ | ordinary grey soil | Artemisia |
| | spring grazing | N 43°27′17.8″; E 074°55′46.2″ | | Artemisia – Ceratocarpus – Carex – Alyssum |
| Foothill dry steppe zone – 1370 ha | summer grazing | N 43°28′58.8″; E 074°50′43.8″ | light chestnut soil | Stipa – Poa – Artemisia |
| Foothill steppe zone – 950 ha | autumn grazing | N 43°19′46.4″; E 075° 01′02.2″ | dark chestnut soil | Poa – Onobrychis – Festuca – Alyssum |

The soil is in constant interaction with other geospheres, other components of the biosphere. It is constantly exposed to natural waters, precipitation, vegetation and other factors. Under the influence of these factors external to the soil, the formation of the soil and its functioning take place. Each soil formation factor has its own specific manifestation. The soil-forming rock is the basis on which and from which the soil is formed.

The material composition of the soil is largely determined by the nature of the soil-forming rock. The granulometric and mineralogical composition of the soil and many of its chemical properties depend on the soil-forming rock. In this regard, in the process of research, the influence of seasonal use of pastures on the main indicators of soil fertility was studied. One of the main indicators of soil fertility is the content of humus and the presence of nutrients (Table 3).

Table 3 – Content of humus and nutrients in the soils of the project area

| Year | Variant | | Sampling depth, cm | Indicators | | | |
|---|---|---|---|---|---|---|---|
| | | | | Humus, % | Total nitrogen, g / kg | Mobile phosphorus, mg / kg | Mobile potassium, mg / kg |
| 2015 | Artemisia | (foothill semi desert zone) (control) | 0 – 10 | 0. 68 | 0. 048 | 19. 4 | 242 |
| | | | 10 – 20 | 0. 47 | 0. 033 | 7. 4 | 201 |
| | | | 20 – 30 | 0. 29 | 0. 013 | 1. 8 | 174 |
| | Artemisia – Ceratocarpus – Carex – Alyssum | (foothill semi-desert zone) | 0 – 10 | 1. 07 | 0. 063 | 25. 8 | 252 |
| | | | 10 – 20 | 0. 77 | 0. 042 | 9. 4 | 221 |
| | | | 20 – 30 | 0. 35 | 0. 026 | 3. 9 | 219 |
| | Stipa – Poa – Artemisia | (foothill dry steppe zone) | 0 – 10 | 2. 12 | 0. 095 | 32. 4 | 314 |
| | | | 10 – 20 | 1. 43 | 0. 058 | 11. 8 | 251 |
| | | | 20 – 30 | 0. 61 | 0. 043 | 5. 3 | 218 |
| | Poa – Onobrychis – Festuca – Alyssum | (foothill steppe zone) | 0 – 10 | 3. 15 | 0. 119 | 42. 6 | 328 |
| | | | 10 – 20 | 2. 69 | 0. 081 | 16. 1 | 272 |
| | | | 20 – 30 | 1. 31 | 0. 055 | 7. 7 | 226 |
| 2017 | Artemisia | (foothill semi desert zone) (control) | 0 – 10 | 0. 56 | 0. 044 | 18. 6 | 245 |
| | | | 10 – 20 | 0. 38 | 0. 028 | 6. 7 | 219 |
| | | | 20 – 30 | 0. 22 | 0. 011 | 1. 6 | 181 |
| | Artemisia – Ceratocarpus – Carex – Alyssum | (foothill semi-desert zone) | 0 – 10 | 1. 12 | 0. 092 | 26. 9 | 261 |
| | | | 10 – 20 | 0. 83 | 0. 068 | 10. 8 | 227 |
| | | | 20 – 30 | 0. 40 | 0. 042 | 5. 3 | 208 |
| | Stipa – Poa – Artemisia | (foothill dry steppe zone) | 0 – 10 | 2. 18 | 0. 117 | 35. 3 | 324 |
| | | | 10 – 20 | 1. 57 | 0. 082 | 12. 6 | 262 |
| | | | 20 – 30 | 0. 77 | 0. 059 | 7. 2 | 220 |
| | Poa – Onobrychis – Festuca – Alyssum | (foothill steppe zone) | 0 – 10 | 3. 26 | 0. 136 | 47. 1 | 344 |
| | | | 10 – 20 | 2. 83 | 0. 097 | 17. 6 | 278 |
| | | | 20 – 30 | 1. 49 | 0. 067 | 8. 4 | 238 |

The results of studies of the chemical properties of the soil show that the content of total humus and nutrients – total nitrogen and mobile phosphorus in the soil is low, with the exception of mobile potassium, regardless of the types of pastures. At the beginning of research (in 2015), the content of total humus in the upper 0 – 10 cm soil layer in the control variant was 0.68 %, in the area of spring use – 1.07 %, summer – 2.12 % and autumn use – 3. 15 %. When moving to the next soil horizon (10 – 20 cm), its amount gradually decreases and amounts to: in the control variant of the experiment – 0.47 %, in the version of spring use – 0.77 %, summer use – 1.43 % and autumn use – 2. 69 %. Determination of the content of total humus in the 20 – 30 cm soil layer showed that the amount of humus is sharply reduced, almost twofold, and ranges from 0. 29 to 0. 61 %. Similar data were obtained when determining the total nitrogen in the soil. Here, the amount of total nitrogen in the upper layer ranges from 0.048 to 0.119 g / kg, in the 10 – 20 cm layer – from 0.033 to 0. 081 g / kg and in the 20 – 30 cm layer – from 0.013 to 0.055 g / kg of soil. As for mobile phosphorus, a different picture is observed. Here, the content of the mobile form of phosphorus, depending on the variants of the experiment, in the upper 0 – 10 cm soil layer ranges from 19. 4 to 42. 6 mg / kg. However, when moving to the next layer (10 – 20 cm), its amount drops sharply and ranges from 7.4 to 16. 1 mg / kg, almost three times, and in the 20 – 30 cm layer of soil it does not exceed the mark – 7. 7 mg / kg of soil.

The obtained data show that the soil is rich in potassium and its amount in the upper 0 – 10 cm soil layer ranges from 242 to 328 mg/kg of soil. At the end of the research (2017), soil fertility indicators in seasonal areas of use, compared to 2015, slightly increased due to the normalized grazing of livestock. Here, depending on the depth of soil sampling, at the plot of spring use, the content of total humus was in the range from 0.40 to 1.12 %, total nitrogen – from 0. 042 to 0. 092 g / kg, mobile phosphorus – from 5. 3 to 26. 9 mg / kg and mobile potassium – from 208 to 261 mg / kg of soil. At the plot of summer use, the amount of total humus

ranges from 0.77 to 2.18 %, total nitrogen – from 0.059 to 0.117 g / kg, mobile phosphorus – from 7.2 to 35.3 mg / kg and mobile potassium – from 220 to 324 mg / kg soil. In the area of autumn use, these indicators were respectively – 1.49 – 3.26 %; 0.067 – 0.136 g / kg; 8.4 – 47.1 and 238 – 344 mg / kg of soil. It should be noted that in the control variant of the experiment, the indicators of the chemical properties of the soil are low, and, depending on the depth of soil sampling, are: total humus – from 0.22 to 0.56 %, total nitrogen – from 0. 011 to 0. 044 g / kg, mobile phosphorus – from 1. 6 to 18. 6 mg / kg and mobile potassium – from 181 to 245 mg / kg of soil. From the data obtained, it can be seen that the lowest amount of total humus and nutrients in the soil was observed in the near-village pasture, which is natural, since in this variant of the experiment, irregular grazing is carried out. Thus, the use of distant pastures seasonally with normalized cattle grazing has a positive effect on soil fertility.

The rational use of natural pastures can multiply the intensification of animal husbandry at feedlots, since feed costs per unit of production and labor costs are very low, which allows you to obtain authentic and inexpensive livestock products. This indicates a very beneficial effect of forage and pasture animal husbandry on the economy of production of the most important livestock products. In addition, the rational use of pastures has a significant impact on soil fertility, creates conditions for vegetation restoration, prevents land degradation and increases pasture productivity.

Economic efficiency calculations take into account only the basic costs of raising and grazing livestock during the pasture period (Table 4). The grazing period was 184 days. Grazing began in May and ended at the end of October. An average of 12 rams, 500 ewes and 523 lambs have been grazing in remote areas for three years this year. An average of 12 rams, 500 ewes and 474 one-year-old lambs grazed at the control sites for three years. Cattle grazing was carried out by two people (shepherds), who were paid 6000 tenge per month each, or 7200.000 tenge for six months. Two horses were purchased for grazing at a price of 500.000 tenge.

Table 4 – Economic efficiency of livestock grazed on natural pastures during the grazing period

| Animals | Variant (groups) | Live weight of animals, kg/head | | Carcass weight, 1st head, kg | The selling price of 1 kg of meat, tenge | The cost of one carcass (meat), tenge | The profit of the experimental group to the control group, per 1 head, tenge |
|---|---|---|---|---|---|---|---|
| | | spring (the beginning of the experience) | autumn (the end of the experience) | | | | |
| Rams | control | 81. 060 | 83. 080 | 41. 540 | 1. 300 | 54002. 0 | 2190. 5 |
| | experimental | 83. 380 | 86. 450 | 43. 225 | | 56192. 5 | |
| Ewes | control | 49. 580 | 52. 260 | 26. 130 | | 33969. 0 | 5213. 0 |
| | experimental | 49. 550 | 60. 280 | 30. 140 | | 39182. 0 | |
| One-year-old lambs | control | 15. 650 | 30. 720 | 15. 360 | 1. 400 | 21504. 0 | 6048. 0 |
| | experimental | 16. 180 | 39. 360 | 19. 680 | | 27552. 0 | |

The cost of meat sales amounted to 200.000 tenge. As a result, the cost of grazing cattle during the pasture period for the experimental group amounted to 154,000 tenge, for the control group – 142.000 tenge. The shepherds from the control group did not spend money on feed; other expenses were the same for both groups.

Considering that the slaughter weight of the carcass is 50% of the live weight, the slaughter weight of one carcass in the experimental group was 41.540 kg/head of rams, and in the control group – 43.225 kg/head, ewes – 26. 130 and 30.140 kg/head and one-year-old lambs – 15. 360 and 19.680 kg/head. A comparison of the carcass weight of cattle in the experimental and control groups shows that the carcass weight of rams in the experimental group increased by 1.685 kg/head, ewes – by 4.010 kg/head and one-year-old lambs – by 4.320 kg/head compared with animals in the control group. The selling price of one kilogram of rams and ewes meat was 1.300 tenge and one-year-old lambs – 1.400 tenge. The price for the carcass (meat) for the experimental group of rams was 56192.5 tenge, for the control group 54002.0 tenge, for ewes 39182.0 tenge and 33969.0 tenge and for one-year-old lambs 27552. 0 tenge and 21504.0 tenge. Based on the results obtained, the net profit of the experimental group of rams at the time of meat sales amounted to 2190.5 tenge per head, ewes – 5213.0 tenge per head and one-year-old lambs – 6048.0 tenge per head.

**Conclusions.** Thus, calculations of economic efficiency show that the proposed development, i.e. the seasonal use of natural pastures and the further use of inter-seasonal rotation of pastures, is the most effective and profitable measure compared with systematic grazing.

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## ГРАФО-АНАЛИТИЧЕСКИЙ МЕТОД ОПРЕДЕЛЕНИЯ НАПРЯЖЕНИЙ В ПОЧВЕННОМ СЛОЕ ПОД ДЕЙСТВИЕМ ДВУГРАННОГО КЛИНА

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*Показано, что исследование процесса распределения напряжений в почвенном слое является важным этапом проектирования почвообрабатывающих машин в целом и почвообрабатывающих рабочих органов в частности. Отмечено, что экспериментальное выявление закономерностей между зоной распределения напряжений в почвенном слое и параметрами почвообрабатывающих рабочих органов является трудоемким процессом и целесообразно предварительное математическое моделирование данного процесса для минимизации общего количества опытов. (Цель исследований). Разработка графо-аналитического метода, который позволит на этапе теоретических исследований, определить закономерность между зоной распределения напряжений перед двугранным клином и его параметрами. (Материалы и методы). При проведении исследований были использованы положения классической и земледельческой механики. В основу методики были положены такие методы научного познания как математическое моделирование, абстрагирование, анализ и синтез. (Результаты и обсуждение). На основании уравнения предложенного J. Boussinesg разработан графо-аналитический метод для определения напряжений, возникающих в почвенном слое под воздействием двугранного клина, который учитывает влияние параметров двугранного клина и физико-механические характеристики почвы. Предложенный графо-аналитический метод может быть использован при проектировании почвообрабатывающих рабочих органов. Например, для обоснования вылета долота плоскорежущего рабочего органа на этапе теоретических исследований. (Выводы). Установлено, что между длиной двугранного клина и общей площадью деформируемой почвы имеется прямо пропорциональная зависимость. Так, при увеличении длины двугранного клина на 83 процента (с 0,05 до 0,30 метров) площадь деформируемой почвы увеличилась на 80 процентов (с 0,02 до 0,10 метров квадратных).*

***Ключевые слова:*** *двугранный клин, напряжения, деформация почвы, графо-аналитический метод, уравнение J. Boussinesg.*

## ЕКІ ҚЫРЛЫ СЫНА ӘСЕРІНЕН ТОПЫРАҚ ҚАБАТЫНДАҒЫ КЕРНЕУДІ АНЫҚТАУДЫҢ ГРАФО-ТАЛДАМАЛЫҚ ӘДІСІ

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*Топырақ қабатындағы кернеудің таралу процесін зерттеу жалпы топырақ өңдейтін машиналарды және әсіресе топырақ өңдейтін жұмыс органдарын жобалаудағы маңызды кезең болып табылатыны көрсетілген. Топырақ қабатындағы кернеулердің таралу аймағы мен топырақ өңдейтін жұмыс құралдарының параметрлері арасындағы заңдылықтарды тәжірибелік түрде анықтау еңбекті көп қажет ететін процесс және тәжірибелердің жалпы санын барынша азайту үшін бұл процесті алдын ала математикалық модельдеу орынды екендігі атап өтілген. (Зерттеудің мақсаты). Теориялық зерттеу сатысында екі қырлы сынаның алдындағы кернеудің таралу аймағы*