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ASSESSMENT OF ENVIRONMENTAL SAFETY INDICATORS OF RURAL AREAS

АУЫЛДЫҚ ЖЕРЛЕРДЕГІ ЭКОЛОГИЯЛЫҚ ҚАУІПСІЗДІК КӨРСЕТКІШТЕРІН БАҒАЛАУ

ОЦЕНКА ПОКАЗАТЕЛЕЙ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ В СЕЛЬСКОЙ МЕСТНОСТИ

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Abstract. The article shows the features of quantitative assessment of the use of natural resources in agricultural sector, environmental impact factors in order to develop adaptation scenarios and mitigate their consequences are identified. This is an alternative option for environmentally sustainable development in agriculture, which allows rational use of land resources. *The purpose* of the study is to determine the criteria for assessing the impact of agriculture on the environment components, in particular on the atmosphere, hydrosphere and land resources. *Methods* of economic analysis, comparison, synthesis, decomposition are used for a comprehensive assessment of the functioning of an enterprise in production of agricultural products. In the process of working on this topic, the following results were obtained: an assessment of the impact of functioning of agro-industrial complex on the environment was done. According to the current methods for determining the degree of impact on land resources, the soil quality scores were calculated before and after it. Anthropogenic pressure on the atmosphere and water resources was assessed in accordance with equivalent indicators. On the basis of the results, the authors present recommendations and conclusions on the determination of data characterizing the impact of the stages of agricultural production on the environment. *The results* of the calculations make it possible to make forecasts and assess the level of environmental safety in agricultural production.

Аңдатпа. Мақалада аграрлық секторда табиғи ресурстарды пайдалануға сандық бағалау жүргізудің ерекшеліктері көрсетілген, бейімделу және олардың салдарын жұмсарту сценарийлерін әзірлеу мақсатында қоршаған ортаға әсер ету факторлары анықталған. Бұл жер ресурстарын ұтымды пайдалануға мүмкіндік беретін ауыл шаруашылығындағы экологиялық тұрақты дамудың балама нұсқасы. Зерттеудің *мақсаты* – ауыл шаруашылығының қоршаған орта компоненттеріне, атап айтқанда атмосфераға, гидросфераға және жер ресурстарына әсерін бағалау өлшемдерін анықтау. Ауылшаруашылық өнімдерін өндіруде кәсіпорынның жұмысын жан-жақты бағалау үшін экономикалық талдау,

салыстыру, синтез, ыдырау *әдістері* қолданылған. Осы тақырып бойынша жұмыс барысында келесі *нәтижелер* алынған: агроөнеркәсіптік кешен жұмысының қоршаған ортаға әсерін бағалау жүргізілген. Жер ресурстарына әсер ету дәрежесін анықтаудың қолданыстағы әдістемелеріне сәйкес топырақ бонитетінің баллына дейін және одан кейін есептеу жүргізілген. Атмосфераға және су ресурстарына антропогендік қысымды бағалау баламалы көрсеткіштерге сәйкес жүзеге асырылған. Алынған нәтижелер негізінде авторлар ауыл шаруашылығы өндірісі кезеңдерінің қоршаған ортаға әсерін сипаттайтын деректерді анықтау бойынша ұсыныстар мен *қортындылар* ұсынылған. Есептеу нәтижелері ауылшаруашылық өндірісіндегі экологиялық қауіпсіздік деңгейін болжауға және бағалауға мүмкіндік береді.

Аннотация. В статье показаны особенности проведения количественной оценки использования природных ресурсов в аграрном секторе, выявлены факторы воздействия на окружающую среду с целью разработки сценариев адаптации и смягчения их последствий. Это альтернативный вариант экологически устойчивого развития в сельском хозяйстве, позволяющий рационально использовать земельные ресурсы. *Цель исследования* – определить критерии оценки влияния сельского хозяйства на компоненты окружающей среды, в частности на атмосферу, гидросферу и земельные ресурсы. Использованы *методы* экономического анализа, сравнения, синтеза, декомпозиции для комплексной оценки функционирования предприятия при производстве сельскохозяйственной продукции. В процессе работы над данной темой получены следующие *результаты*: проведена оценка влияния функционирования агропромышленного комплекса на окружающую среду. Согласно действующим методикам определения степени воздействия на земельные ресурсы рассчитаны баллы бонитета почв до и после него. Оценка антропогенного давления на атмосферу и водные ресурсы осуществлена в соответствии с эквивалентными показателями. На основе полученных результатов авторами представлены *рекомендации и выводы* по определению данных, характеризующих воздействие этапов сельскохозяйственного производства на окружающую среду. Результаты расчетов позволяют сделать прогнозы и оценить уровень экологической безопасности в сельскохозяйственном производстве.

Key words: agro-industrial complex, environment, environmental assessment, anthropogenic impact, decomposition method, equivalents, soil quality, atmosphere, hydrosphere.

Түйінді сөздер: агроөнеркәсіптік кешен, қоршаған орта, экологиялық бағалау, антропогендік әсер, ыдырау әдісі, эквиваленттер, топырақ бонитеті, атмосфера, гидросфера.

Ключевые слова: агропромышленный комплекс, окружающая среда, экологическая оценка, антропогенное воздействие, метод декомпозиции, эквиваленты, бонитет почвы, атмосфера, гидросфера.

Introduction. Nowadays significant changes have been taking place in environmental legislation of Kazakhstan as the "Environmental Code of the Republic of Kazakhstan" No. 400-VI has entered into force since January 2, 2021. Annex 3 of the legislation mentioned defines a list of areas of application for the best available technologies (BAT) application [1]. Regulatory documents are also being developed to ensure the implementation of the BAT system in the industry [2]. In accordance with Article 65 of the Environmental Code of the Republic of Kazakhstan "The obligation to conduct an environmental impact assessment". Legal entities and individual entrepreneurs engaged in economic and (or) other activities at Category II facilities are required to obtain a "Comprehensive Environmental Permit". When assessing livestock/poultry complexes those also falls under the BAT system and are required to receive an EIA.

Material and methods of research. In order to facilitate the assessment of adaptation scenarios and mitigate their consequences, it is necessary to determine the impact of animal husbandry on the environment, in order to increase the sustainability of the livestock sector.

The model can be applied on a national, regional and global scale. GLEAM-highlights the key stages of livestock production: production, processing and transportation of feed; herd dynamics, animal fattening, cleaning, storage and use of manure; processing and transportation of livestock products. The model makes it possible to fix specific impact factors at each stage, to obtain a general and detailed picture of livestock production and the corresponding use of natural resources. The model of ecological assessment of world livestock

production was developed in order to analyze multiple environmental impact measurements: feed use, greenhouse gas emissions, land use and soil degradation, water use and nutrient use, interaction with biodiversity [3].

The stages of such environmental impact from the livestock and poultry complex are grouped by us in figure.

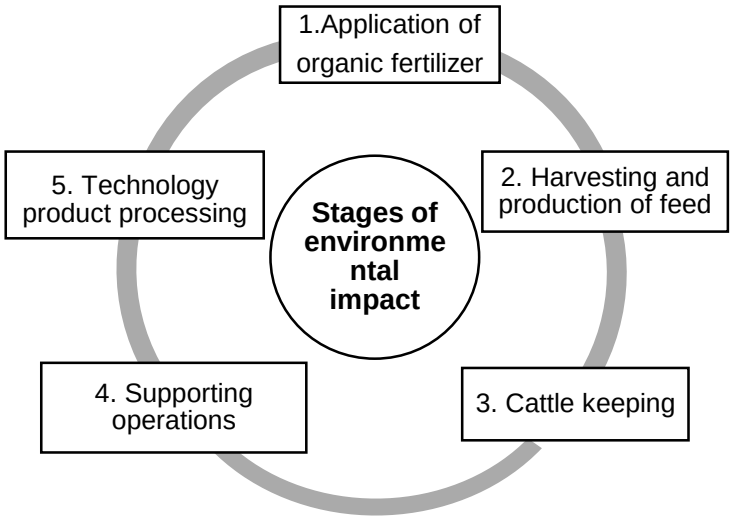

Figure - Stages of environmental impact

The most significant impact is due to the impact of three main assessment indicators, which are determined by soil (Is), atmosphere (Ia) and hydrosphere (Ih).

It should be noted that in order to reduce the degree of impact on the soil, it is necessary to combat erosion, reclamation, apply organic fertilizers, grass sowing, liming of acidic soils, minimal impact of heavy machinery on the soil cover, soil protection technologies, biological methods of plant protection, the use of crop rotations with pure vapors, etc. Naturally, along with this, mineral fertilizers should be applied in an optimal mode and pesticides should be used against agricultural pests [4].

To ensure the environmentally sustainable condition of the rural area, it is necessary to ensure the condition:

$$K_s = \frac{I_l}{R_n} < 1 \qquad (1)$$

I_l – the impact of the livestock/poultry complex on the environment; R_n– natural resources.

$$I_l = f(I_a, I_s, I_h) \qquad (2)$$

I_a – the impact of the livestock/poultry complex on the atmosphere; I_s – the impact of the livestock/poultry complex on the soil; I_h – the impact of the livestock/poultry complex on the hydrosphere.

$$R_n = f(C, P, K) \qquad (3)$$

C - the background concentration in the atmosphere; P - the degree of absorption of the substance by the soil cover; K - the assimilation coefficient [5].

Results and their discussion. One of the most important measures is to prevent the degradation of agricultural land, improve the breed of animals based on breeding work, the introduction of resource-saving technologies, and the formation of guaranteed veterinary services for livestock farms, private farms and other forms of ownership. Since the development of animal husbandry is closely related to nature, it becomes necessary to monitor the state of the environmental burden, the purpose of environmental safety, to unify sanitary standards in accordance with international requirements.

The natural damage caused by the ill-conceived policy of developing new technologies from an ecological standpoint is enormous. Old technologies have led to the spread of wind erosion, which has led to the loss of large areas. The replacement of biocenoses with agrocenoses in vast territories caused climate change, an increase in its aridity, an increase in the number of droughts, and an increase in aridization processes. All this confirms the need for careful consideration of the environmental factor in agricultural policy. To assess the impact of agricultural production on the soil cover, we determined a bonus point using the formula below: As a complex indicator of the impact on the soil Ksl is the change in the bonus score, which is calculated by the formula:

$$K_{sl} = BS_a - BS_b \qquad (4)$$

BS_a – soil bonitet score after anthropogenic impact; BS_b – soil bonitet score before anthropogenic impact.

To assess the overall indicator for the soil, the conditions typical for the Southern Kazakhstan region were chosen – gray soils and gray-brown soils. They occupy 120 million hectares, or 44% of the territory of the country. In general, only Turkestan region is 11725.8 thousand hectares. Including land used for agricultural uses – 6815.7 thousand hectares, arable land – 911.4 thousand hectares (including irrigated arable land – 457.3 thousand hectares). Pastures make up 5635.8 thousand hectares, hayfields – 84.5 thousand hectares, perennial plantings – 29.0 thousand hectares. The humus content in these varies around 2.0% - 1.0%. Basically, this is a livestock area; agriculture is possible only with irrigation [6].

One of the main reasons for this situation is that the most important component of agricultural technology crop rotation is poorly used. On dry soils, the bonitet score should be 25, but actual is 19. Every year, the bonus score decreases because crop rotation is not used, organic fertilizers are not applied, and minerals are not used in an appropriate quantity. Studies of the regional branch of the Republican Scientific and Methodological Center of the Agrochemical service revealed that humus decreased by 0.14% in the soil of agricultural lands of the Turkestan region, nitrogen content decreased by 5.6%, and mobile phosphorus decreased by 1.7%. We will calculate the soil bonus points according to the Method [7], using the example of this area.

The predominant soils are low humus gray soils (in a half-meter layer of soil they contain only 0.8-0.9% humus), because of the peculiarities of the natural process of soil formation. However, these soils are rich in elements of mineral nutrition, and thanks to favorable thermal resources and irrigation, they provide a high yield of valuable crops: cotton, sugar beet, fruits, and vegetables. Let's assume that the average humus content in the estimated irrigated gray- soil is 0.85%. The negative properties of the soil have not been identified. Dividing the humus value by the standard adopted by the Methodology – 2.5%, we get a soil bonus equal to 34 points. According to the classification, this soil is assessed as "low" in quality. The same is the case with non-irrigated soils of the Turkestan region. So, ordinary non-irrigated gray soils are used for the cultivation of grain crops (insufficiently provided dry soils). Dividing, in this case, the humus value by the standard adopted by the Methodology – 7%, we get a soil bonus equal to 12 points.

According to the classification, this is the value of the soil bonus score, estimated as the "worst" in fertility. Above the belt of gray-earth soils, there are dark gray soils (gray-brown soils), which are good non-irrigated soils, sufficiently provided with atmospheric precipitation, where winter wheat, fruit, etc. produce good yields. Dark gray soils in a layer of 0-50 cm contain on average about 2% humus. Now dividing the average humus index -2% by the standard set by the Methodology - 7%, and conditionally if the assessed soil does not have negative properties, we will get a bonus of non-irrigated dark gray soil equal to 28 points. The calculated score, according to the accepted classification, corresponds to soils of "very low quality". Thus, both irrigated and non-irrigated soils of the Turkestan region, assessed according to the Method [lk.7], are classified as "low" and "very low" in quality and fertility. The bonus score before exposure was 28, and after exposure – 25. The average humus content in the soil was used as the estimated soil parameters. In this case, the value of a negative impact on the soil is – 3. At this value a loss of potential yield for grain crops (other things being equal) can be up to 1.13 c/ha.

As is known, the main pollutants of atmospheric air are emissions of pollutants such as nitrogen dioxide, ammonia, and hydrogen sulfide. In calculating the concentration of the degree of exposure, data on the background concentration of these substances can be used. The branch of RSE "Kazhydromet" provides background information on the requested districts and regions [8].

The impact of agricultural enterprises on the environment for each impact indicator is assessed by applying formulas such as:

Global warming

$$I_{GWP} = \frac{GWP_{base}}{M_{base}} \times \frac{GWP_{target}}{M_{target}}, \quad (5)$$

Acidification

$$I_{AP} = \frac{EF_{ibase}}{M_{base}} \times \frac{EF_{itarget}}{M_{target}}, \quad (6)$$

Eutrophication

$$I_{EPfact} = \frac{EF_{ibase}}{M_{base}} \times \frac{EF_{target}}{M_{target}} \quad (7)$$

i.e. M_{base}, M_{target} – the mass of the products is actual and when using the ideal technology [lk. 5].

According to the formulas presented above for each category of influence (I) (warming, eutrophication, acidification) all impacts are evaluated in a single dimension. Ideally, then it is necessary to identify the degree of influence of the impacts and determine the weighting factors. However, it can be taken into account that all impact categories are equal to

each other and then all indicators are summed up to obtain an overall assessment [9]:

$$KA = I_{GWP} + I_{AP} + I_{EP} \qquad (8)$$

If we also take into account that a significant amount of pollutants discharged into the hydrosphere as a result of the anthro-pogenic impact of the agricultural industry are phosphorus and nitrogen compounds, the impact of the eutrophication process increases. The indicators characterizing the level of pollution are presented in table.

Table - Environmental pollution assessment indicators

Type of ecological disaster/phenomenon/event	Equivalent indicator	Potential pollution evaluation
Toxic effects on humans	the MPC in water is used as the equivalent of toxicity	EPhum,m = nEQFi,m x m_i, [kg I- TEQ], EQFi,m – equivalent for the substance; m_i – ejection mass / emissions of the substance i
Eutrophication	Phosphorus of phosphates (P; PO_4)	EP fact= EF_i x m_i [kg PO_4 – equivalent.] EF_i equivalent for the substance i; m_i – ejection mass / emissions of the substance i

To substantiate the criterion of the impact of agricultural production on the hydrosphere, the methodology is used as well as to assess the impact on the atmosphere. This methodology is proposed in ISO 14040 "Life cycle assessment" - Environmental assessment of the life cycle of products [10].

Pasture animal husbandry is the cheapest than other types of farming, where about 60-70% of the necessary feed is obtained. Pasture overloads take place mainly near farms, villages, especially on sandy massifs with irregular grazing of livestock. In this regard, it is necessary to rationally use the lands without overloading them with cattle, conduct pasture-protective measures and sowing fodder grasses.

Desertification and land degradation due to the destruction of soil and vegetation cover is a global environmental problem. It should be noted that, according to the analysis of the state of land resources, soils undergo the most significant transformation when used as pastures for animal husbandry, which so changes the morphological appearance of soils and their chemical and physical properties that as a result they are smoothed out under typical and even typical differences of the original soils.

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Conclusions.

1. The environmental factor is external to production. We are talking about the development of criteria and levels of environmental friendliness of production in the form of a system of appropriate indicators. Under these conditions, the definition of a single comparable criterion for the greening of production is a necessary prerequisite for improving the process of environmental protection management and ensuring sustainable development.

2. The main drawback in the placement and planning of the agricultural sector is the adoption of decisions that determine the main directions of development, without forecasting their environmental consequences, without taking into account the ability of the environment to maintain the stability of ecosystems as a whole.

3. The criteria for assessing the impact on the components of the environment of the entire technological chain of agricultural production based on the decomposition method are substantiated, which make it possible to determine and take into account this impact in the long term.

4. As a result of the impact of the agricultural sector, an assessment of the soil bonus score in the Turkestan region was carried out. To substantiate the impact on the atmosphere and water bodies, a methodology based on the determination of analog values is presented.

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