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Improvement of methods of rational use in conditions of land degradation in the Almaty region, Karasai district

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Abstract. The study was aimed at identifying the potential of modern methods of rational land use in the Karasai district of the Almaty region of Kazakhstan, taking into account their intensive degradation. The research methodology was represented by the methods of statistical observation, comparison, analytical-structural grouping and forecasting. The priority goals of modernisation of agriculture of the Republic in the technological aspect have been analysed. It was established that innovative

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approaches to land use have the potential to increase the level of efficiency of the agrarian sector, improve the state of local and regional landscape. The concept of improving the state of degraded lands, including a system of management measures and practical activities, has been developed. It was proved that it should be based on the synergy of economic efficiency and environmental safety, with the mandatory introduction of modern innovative technological approaches. The effectiveness of methods of rational use of degraded lands as an effective tool for the transformation of the agrarian sector has been determined. It was proposed to intensify the development of organic agricultural production, which is positioned as the gentlest for degraded landscapes. It was proved that the implementation of sustainable management of landscape complexes in the innovative context implies the use of information monitoring technology, which anticipates the diagnosis, genesis and forecasting of the state of the studied ecosystems. Such measures will make it possible to develop programmes for the restoration of ecological functions of natural landscapes, which is an integral part of sustainable development programmes. Actualised the situation in the context of ecologisation of land use in Kazakhstan, predicted further destruction of ecosystems of agrarian landscapes in case of use of aggressive methods of soil cultivation. The necessity of introduction of improved methods of rational land use is substantiated, and the specificity of the introduction of organic and biological technologies of agricultural production is outlined, with an indication of tangential risks and challenges in the economic realities of Kazakhstan. The study substantiated that the application of integrated management and ecosystem approach have a synergistic potential to ensure the rational use of land in the Almaty region, the Karasai district in the conditions of their degradation

Keywords: farming; sustainable development; modernisation; intensification; organic production

INTRODUCTION

Pollution of soil cover, and depletion due to irrational use, lead to undesirable ecological consequences for the land resources of Kazakhstan. Intensification of land use for a long time contributed to large-scale chemicalisation of soils, development of processes of their salinity, erosion, and minimization of organic matter content. Natural processes of regeneration and self-purification do not provide renewal of degraded natural landscapes. The low threshold of natural resistance of land resources of the Republic to degradation is due to the narrow homeostatic range, peculiarities of natural resource potential, and insignificant adaptive capacity. Increasing requirements for the quality of agricultural products in the global market environment leads to the need to search for new opportunities for the formation of competitive advantages of agricultural producers in crisis conditions, which in synergy will allow the national agricultural sector to increase and maintain its own position in the market, while minimizing further land degradation.

Today, special attention is paid to improving the economic efficiency of the agricultural sector to form sustainable competitiveness in a dynamic market environment (Pasichnyk *et al.*, 2023). The development of agricultural production in Kazakhstan in the concept of prioritization of the foundations of sustainable development requires the introduction of gentle farming techniques. Such a strategy to ensure competitiveness of the greatest functionality focuses on internal and external investment in promising projects, the implementation of innovative solutions and practical developments of successful international experience, the establishment of mechanisms for financing projects of organic production.

In the Karasai district of the Almaty region, the qualitative change of land is clearly demonstrated. Destructive processes have a negative systemic impact on all tangential components of the ecosystem. Under such conditions, the necessity of formation and introduction of a new conceptual approach to the regional land use strategy is actualised. Many scientific works and researches of the present day are devoted to the improvement of methods of rational use in the conditions of land degradation (Skliar *et al.*, 2024). Strategies of technological modernization of farming, and gentle methods of soil cultivation, which raise the level of economic efficiency and environmental safety, are studied in the works of modern authors E.A. Guliyeva (2021) and G.K. Kurmanova *et al.* (2022). Researchers focus on the practical aspects of organic production through innovative technological solutions that are sparing to the soil, and complementary to the principles of a 'green' economy.

Scientists D. Glover *et al.* (2019) analysed the destructive changes of land resources that are difficult to regenerate. The authors are convinced that degradation is provoked by the long-term accumulation of toxic chemicals in soils from agricultural activities. The researchers are convinced of the feasibility of transforming the traditional land use system to an organic one. In continuation, F. Caffaro *et al.* (2020) investigate organic production as a regulator of ecosystem health. The scientists pay special attention to the potential of technological transfers as a promising vector of innovative transformation of the agricultural industry.

Researchers X. Yin *et al.* (2022) substantiate the functionality of monitoring systems, which they position as the basis of the ecosystem approach to agricultural activities, providing preventive protection against

negative environmental impacts. At the same time, J. Clapp and S.-L. Ruder (2020) conclude in their research that to meet the existing global growth in demand for organic products with limited resource capacity can only be achieved through effective technological modernization of agricultural projects. Researchers M. Herrero *et al.* (2020) propose an integrated approach to optimize the state of degraded lands, within the framework of sustainable development programmes and green economic course. The approach provides measures to neutralise the negative impact of anthropogenic load, maximize the elimination of pollution and regeneration of natural resources, and restore natural landscape complexes.

Without levelling the significance of scientists' conclusions, still many issues in the field of improving methods of rational use in the conditions of land degradation require detailing and searching for optimal solutions. In particular, the processes of integration of organic and precision farming systems in the realities of Kazakhstan are studied fragmentarily. The aim of the study was to analyse the potential of innovative approaches to optimize the rational use of degraded land resources (in the context of the Karasai district of Almaty region of Kazakhstan).

MATERIALS AND METHODS

Statistical observation made it possible to form generalizing information that is representative as a characteristic of the whole set of attributes of the phenomenon under study. In order to determine the level of greening of land use, the main indicators of qualitative changes were compared. The specifics of precision farming development within the strategy of circularity of agricultural production processes have been determined, and measures to improve the management paradigm in the sphere of agrarian production have been proposed. The optimal conditions and solutions in the context of efficiency and expediency of the complex of methods of rational use in the conditions of land degradation on the basis of 'green' economic development and sustainable decarbonisation of technological processes have been specified. Prerequisites for active practical use of organic and precision farming technologies in Kazakhstan are formed.

Analytical and structural grouping allowed forming a step-by-step algorithm for the introduction of innovative gentle farming technologies, taking into account the socio-economic features of activity in the agrarian sector of Kazakhstan, in particular, the Karasai district of the Almaty region. To determine the disadvantages, risks, and advantages of certain solutions in the context of transforming the approach to land use on degraded lands, the forecasting method was used. The synergy of economic feasibility and ecological safety, which forms a system of circular sustainable economic activity, was chosen as the predominant orientation.

To assess the dynamics of organic agriculture development, official statistical information of the Ministry

of Agriculture of the Republic of Kazakhstan (2022) and the Bureau of National Statistics (2024) was used. In addition, the research process used strategic programme documents and regulatory legal acts in the industry under study, in particular, Land Code of the Republic of Kazakhstan (2003), Law of the Republic of Kazakhstan No. 464-IV (2011), the Ecological Code of the Republic of Kazakhstan (2021), Strategic measures to combat desertification in the Republic of Kazakhstan until 2025 (United Nations Development Programme, 2015), Kazakhstan's Final Report on the LDN Target Setting Programme (United Nations Convention to Combat Desertification, 2018), and Law of the Republic of Kazakhstan No. 423-IV LRK (2015).

RESULTS

Prolonged extensive land use in the agricultural sector actualises the need to transform traditional production processes towards intensive methods and new technologies. Protection of degraded lands corresponds to the basic paradigm of agricultural sustainability, as the priority of rational use in the conditions of land degradation is determined precisely by the sustainable use of landscapes. The basis for modernisation and ecologisation of land use in Kazakhstan is the state innovation policy, the purpose of which should be renewable resource use, integration of technological achievements and scientific approaches, formation of mechanisms and methods to stimulate innovation activity.

Organic farming has a huge potential for development in Kazakhstan. As of 2024, the total area of fields allocated to organic farming is more than 200 thousand hectares, which is confirmed by European certification organizations Land Code of the Republic of Kazakhstan, 2003; Bureau of National Statistics, 2024). Implementation and adaptation of effective technologies of organic farming, stimulation of targeted investment, professional development form the basis for intensive development of the agricultural sector in the Republic. In 2022 and 2023, Kazakhstan exported organic products worth about 35 million USD (Fig. 1), which demonstrates positive dynamics.

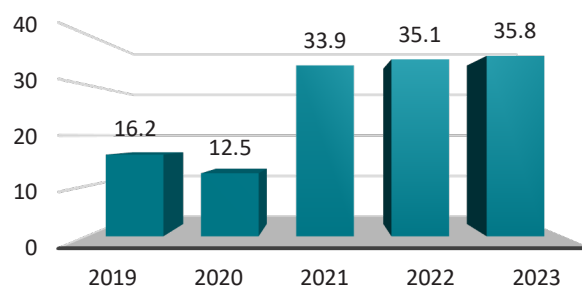


Figure 1. Export of organic products from Kazakhstan to the EU, million USD

Source: developed by the authors, based on Ministry of Agriculture of the Republic of Kazakhstan (2022)

Priority export positions of Kazakhstan are wheat, flax seeds, and soya beans. According to the Ministry of Agriculture of the Republic of Kazakhstan (2022) and Ecological Code of the Republic of Kazakhstan (2021), in Kazakhstan, today there are 38 farms certified for the production of organic products. Certification is a necessary step in the effective development of organic agriculture, significantly increasing the level of trust between producers and consumers. Law of the Republic of Kazakhstan No. 423-IV LRK (2015) and No. 464-IV (2011) defines the basic norms of organic production (social, legal, economic and organizational). They regulate the vector of ensuring the rational use of soils, including degraded soils, and promote environmental protection and food security. Intensification of implementation of precision farming systems is part of the strategy of practical functionality of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services BesNET. The platform was initiated in 2012, and today it unites about 140 countries of the world. Kazakhstan is supported by BesNET through the BES Solutions Fund to scale up and implement the key priorities identified during the Central Asia Regional Dialogue in Almaty in October 2019.

Organic farming has a number of defining parameters, the most significant of which is considered to be the prohibition of aggressive agrochemicals in the production process, which minimizes the negative impact on the environment by preventing chemical pollution and ensuring the preservation of natural soil microflora. In addition, organic farming involves strict adherence to crop rotations so that there is no risk of soil depletion by sowing the same crops. The obligatory use of legumes in the crop rotation allows the soil to be saturated with nitrogen in this natural way (Aldieri *et al.*, 2021). Almaty oblast is a region of Kazakhstan rich in natural resources and with the potential for intensive economic activity. The resource-raw material and monocultural system of nature management has caused the

formation of many environmental problems. On the territory of intermountain valleys of Kegenya and Narynkola, foothill sloping plains of Zailiyskiy Alatau, water erosion processes are a potential danger. The territory has a significant slope and dissection. The mentioned problem concerns also farms of the Karasai district.

Also, gully erosion is actively and universally manifested. In particular, it causes significant damage to natural pastures and fodder lands of the Almaty region, located on slopes. Such phenomena provoke processes of turf destruction and loss of valuable components of pasture grasses. Due to long-term irrational use of territories for irrigated and rainfed farming, the predominant share of pastures in the foothills in the Karasai district is characterized by severe degradation. Soil salinization is observed in the floodplains of rivers and around lakes, which is caused by a violation of the hydrological regime of the landscape ecosystem. Modernisation of sustainable land use practices within degraded landscapes mainly implies the integration of innovative agrotechnologies, optimisation of fertilizer and chemigation systems with priority given to biological methods of plant protection and organic fertilizers (Rose *et al.*, 2021). Implementation of the latest scientific-research developments, contributes to the intensive growth of export potential.

The innovative technology of precision farming involves the preliminary study of agrophysical and agrochemical indicators of fields. On the basis of the collected information, it is reasonable to draw up special electronic maps of fields. GPS systems can be used effectively for this purpose. The new generation of functional field maps makes it possible to develop an optimal individualized system of tillage and fertilization, plant protection, and crop adjustments (Fleming *et al.*, 2021). Precision farming provides for continuous monitoring of soil conditions, which makes it possible to strategically plan a system for optimising the parameters of degraded land (Fig. 2).

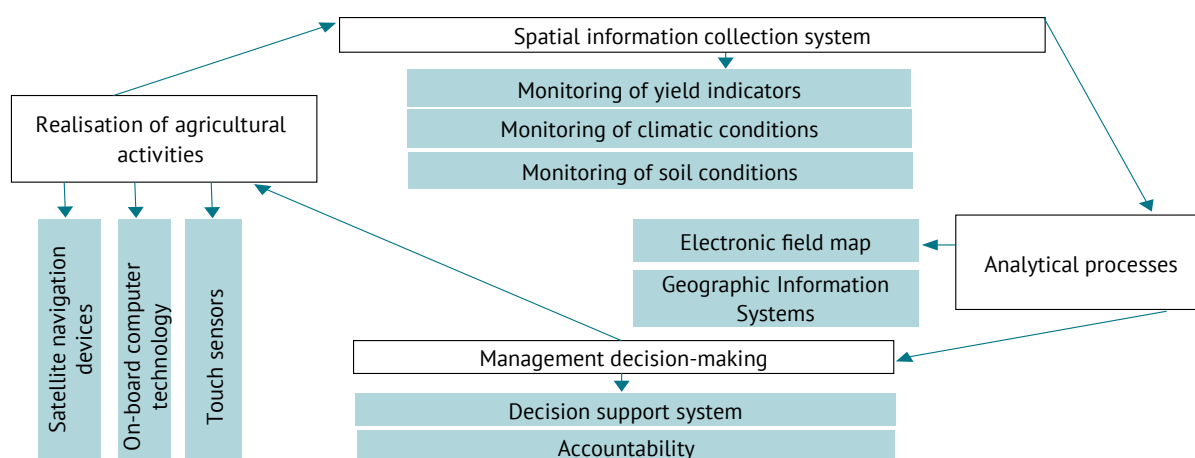


Figure 2. Method of precision farming technology on degraded sites

Source: developed by the authors based on A. Raihan *et al.* (2022)

Technological transformation of land use involves energy efficiency, optimization of irrigation equipment and systems, precision farming concept, and bioenergy strategies. Methods that are tolerant to the natural environment, keeping soil conditions within ecological norms (Kerneck *et al.*, 2021). Innovative technological techniques and algorithms that allow the implementation of a step-by-step transformation of the land use system give a possibility of

guaranteeing compliance with European standards of sustainable development, the scientific validity of ecologization of agrarian processes, and implementation of gentle land cultivation technologies (Rolandi *et al.*, 2021). Strategic management of degraded land resources in Kazakhstan, and, in particular, in the Karasai district of the Almaty region has certain peculiarities. The main factors affecting the process are summarized in Table 1.

Table 1. Limiting factors of management of degraded land resources in Kazakhstan

Limitation factor	Influence
Natural and climatic conditions	Direct dependence of production activities on environmental factors, propensity of the territory to water and wind erosion
Territorial dispersion of production	Difficulty in making timely operational decisions and adjusting strategic plans due to imperfections in the management system
Seasonality	Increased risk of unforecasted performance due to seasonal specificity of impact
Organizational and legal forms of management	Precision farming farms are under significant pressure from external determinants
Regulatory and legislative basis	The need for adaptation to innovative management practices in the context of land degradation

Source: developed by the authors

Thus, among the specific prerequisites for improving land use methods in Karasai district of Almaty region, are identified: specificity of living conditions of the population of rural areas – the basis of the farmer community; dependence on natural and weather-climatic peculiarities, which creates the need to provide a reliable material and technical base; seasonality of agrarian production, which creates unevenness in the use of material resources throughout the year; specificity of production on the basis of living organisms and natural systems, dependence of economic factors of activity on the efficiency of natural reproduction processes.

The main directions of innovation activities within the concept of rational use of land resources, in the future, should be targeted advisory centres, close to the agricultural producer (Clapp, 2021). The level of popularity of agricultural advisory services in Kazakhstan is currently insignificant. At the same time, advisory services can stimulate the improvement of the ecological condition of land, allowing to obtain significant economic benefits based on the integration of innovative technologies (Rocchi *et al.*, 2020). It is possible to highlight specific features of the proposed methodology of rational use in conditions of land degradation in the Almaty region, Karasai district, among which (Ruzzante *et al.*, 2021; Lacoste *et al.*, 2021): low level of accuracy and reliability of forecasting, which is associated with the specific nature of the region; the necessity of optimizing production processes due

to seasonal shortage of basic resources; the need for comprehensive monitoring; systemic problems of agricultural production.

The system of precision organic farming can be considered as the foundation of innovative development in the context of the conservation of degraded lands. Its effective development provides for the gradual and effective achievement of objectives, which include: strengthening of the status in the market environment, diversification of production, development of new sales directions; increasing production volumes, efficient utilization of assets and saving resources; ensuring production stability by stabilizing resource reserves and insuring risks. The precision farming system provides a balance between environmental stability and economic efficiency of agricultural production (Bilushenko, 2023). Minimization of mechanical tillage of the soil cover, absence of chemicalization processes, individualization of agricultural technologies and processes stimulate an increase in demand for organic products, growth of its share in exports, encourage the spread of organic land use in other regions (Sadik-Zada, 2020; Farrokhi & Pellegrina, 2023).

In order to analyse the effectiveness of the introduction of precision farming technology, the rate of implementation of its elements in European countries was analysed, which allows us to predict the positive dynamics of the impact of technology, if implemented, on changes in soil productivity in Kazakhstan (Fig. 3).

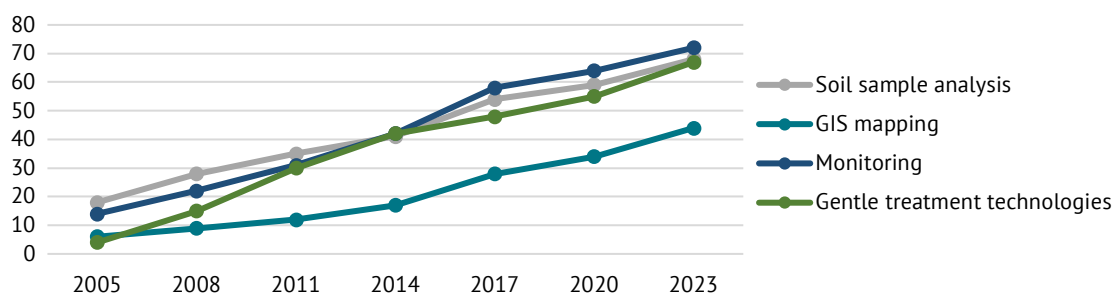


Figure 3. Rate of implementation of precision farming elements in developed European countries, %

Source: developed by the authors based on European Commission (2023)

As is evident from Figure 3, over the period 2005-2023, the process of implementation of precision farming technology and some of its conceptual approaches is characterized by positive dynamics, with a significant intensification of the process after 2014. This period is characterized by global awareness of the level of depletion of the natural potential of landscape resources and the realization of the need for an immediate transition to extensive tillage technology. At the same time, the level of integration of GIS-technologies remains much lower than other elements of precision farming technology, although progressive positive dynamics characterize it.

Introduction of organic production on a large scale in Kazakhstan is limited by the imperfect regulatory and legal framework, the predominant share of exports, underdevelopment of the domestic organic market, limited range of goods, low awareness of the population, lack of investment in organic production. At the same time, there is a significant potential in the industry, which can be unlocked with the help of targeted international support and attract investment opportunities. In the future, an important function is assigned to the integral ecological assessment of soils for comprehensive analysis of the situation and preventive protection of cause-and-effect relationships in the ecosystem. At the same time, a special role in the process should be given to engineering and ecological research, which takes into account that landscapes of this type are an active area of exogenous geological processes.

Mapping for fixing the existing anthropogenic load on degraded land resources should be singled out separately. Cartographic modelling using GIS-technologies is one of the priority methodological bases for research of degraded soils and assessment of their condition (United Nations Development Programme, 2015; United Nations Convention to Combat Desertification, 2018; European Commission, 2023). They demonstrate immediate effectiveness in the context of ecological and landscape monitoring data analysis, digital mapping, forecasting and modelling of the dynamics of natural-anthropogenic systems.

Geoinformation technologies are currently very actively used in the Republic of Kazakhstan. Most of the

projects based on geoinformation systems, which use ESRI software, have already become a standard used in many state enterprises and departments. GIS-technologies are maximally adapted to work in a dynamic geographical environment, and therefore it is expedient to use them for solving problems of ensuring environmental safety and sustainable development of territories with the help of spatially distributed arrays of reliable data (Skydan *et al.*, 2021). On the basis of GIS-technologies, the direction of operative mapping in real-time dimension is created, which forms the possibility of operative influence on the process in case of necessity, as well as an inventory of objects, monitoring of their dynamics, and prognostic analytics.

GIS-technologies actualize the possibilities of preserving degraded lands through ecological and landscape management, in particular through buffering (Fedoniuk *et al.*, 2024). Modern GIS tools allow buffer zones to be formed automatically, and they can be built around objects of any type. Also, a popular aspect of land management is the implementation of network analysis, which is carried out in order to determine the three-dimensional modelling of spatial tasks. Precision farming has a significant resource potential and the prospect of large-scale integration on the territory of Kazakhstan. At the same time, farms, as a small form of entrepreneurship, have a number of advantages in comparison with large agrarian enterprises of agricultural production, in the context of the implementation of precision farming systems: economical logistics, ease of integration into the market environment, increased level of adaptability due to the small scale of production, quick reaction to the dynamics of market conditions. At the same time, in Kazakhstan, the segment of farms needs optimization of the legislative and regulatory-methodological basis for development, as well as stimulation of their competitiveness and profitability by the state.

The ecosystem approach ensures the balance of individual ecosystem components among themselves and with the anthropogenic component (de Janvry & Sadoulet, 2020). Integrated land use in the condition of land degradation will effectively address such strategic objectives as optimization of nature management,

improvement of soil sustainability, prompt response to risks and threats, and quality informative monitoring. Thus, the modern methodology of rational use under conditions of land degradation in Kazakhstan should combine vectors of innovative optimization of agricultural activity, protection of land from destruction, its regeneration, as well as technological modernization of the agricultural sector, which in synergy can provide favourable conditions for the most effective development of sustainable agriculture in Kazakhstan.

DISCUSSION

Increasing the level of ecological sustainability of farming systems in conditions of land degradation is based on the need to integrate precision and organic agrarian production systems to minimize destructive processes. Most modern scientists working in the interdisciplinary field are convinced of this. Scientific research confirms the fact of destructive influence of long-term extensive use of land resources. Scientists I. Cisternas *et al.* (2020) are convinced that the modernization of land use is a gradual transition from traditional economic methods to innovative technological methods, while it should correspond to the priorities of the green economy. The position of scientists reflects the main scientific idea of the current study. In the context of the Almaty region, the level of modernization of economic processes of land use depends on the efficiency of practical implementation of innovative research and development and foreign experience.

Modernisation of degraded land use, according to the research of X. Yang *et al.* (2021), is represented by typical modes of development of intelligent agriculture: precision farming, objective farming and order farming. The authors then derive several underlying technologies and programmes from the above regimes, including blockchain-based solutions for data integrity, cryptography and key management, authentication and access control, physical countermeasures and intrusion detection systems, and privacy preservation. It is worth paying attention to the associated cybersecurity risks, because the strategy of digitalization of management processes proposed by the authors will potentially be accompanied by many threats to information security, on which the efficiency of alternative farming depends. Precision farming forms a direction for the development of alternative systems of gentle farming in degraded areas, which has a particularly promising potential for the Almaty region, given the level of destruction of local ecosystems (Bragina *et al.*, 2018).

C. Gras and D.M. Cáceres (2020) argue that the long-term results of precision agriculture are local regeneration of degraded soils, preventive protection from salinization and erosion processes. The authors analyse the algorithm of influence of modern technological innovations on the level of sustainability of farming. At the same time, it is

possible to discuss with the authors about the expediency of the priority of economic benefit in the context of Almaty region as a representative region of Kazakhstan, because the proposed dialectic position the mediating role of technological innovations to achieve high levels of crop yields and expanding the reach of capital over insufficient and non-capitalised nature.

The results of the review of the scholar R. Práválie (2021) showed that there are currently about twenty ways of land degradation. The most common and destructive among them, the author singles out aridity, erosion phenomena, salinization, and acidification of soil, soil compaction, land pollution and biological invasion, soil subsidence, landslides, and others. The research results of H. Xie *et al.* (2020) demonstrate the evolutionary ways of dynamic monitoring of land degradation, reveal the potential of ecological management. The article concludes that the directions of prospective degradation research should summarize the process, mechanisms, and consequences of destructive impact, the application of new technologies, new methods for monitoring land degradation, improving the reconstruction strategy of degraded land, multidisciplinary integrated system research, building a policy guarantee system for the reconstruction of degraded land and strengthening land resources engineering research. In the concept proposed by the authors, from the point of view of possibilities of its implementation in the region of Almaty oblast, it is worth adding the possibilities of levelling the negative effects on land resources by introducing protective buffer zones, introducing restrictions on the use of heavy agricultural machinery.

S. Mahata and V.N. Sharma (2021) draw attention to the need to implement closed-cycle technologies that minimize the negative impact on the environment. The authors point out the main factors of land degradation, emphasizing on the extent and severity of the process. They also propose innovative methods for assessing landscape and soil conditions. It is worth discussing with scientists about the expediency of using a unified assessment system. Priority should belong to a differentiated methodology that takes into account many regional and local factors of land condition. Precision agriculture contributes to food security. This is convinced in the studies by scientists L. Olsson *et al.* (2019). According to the authors, large-scale use of digital maps and GIS technologies allows for preventive protection of land from degradation, which will increase the efficiency of agricultural production. The creation of an interactive map of degraded lands in the Almaty region will allow for the most effective coordination of efforts to optimize the land use system.

A. Hossain *et al.* (2020) offer potential solutions to reduce soil degradation through understanding integrated land management practices. The study contains relevant information on the account of agricultural development, topography, economics and environmental

management. It should be emphasized that the proposals of the scientists are foreseen to be feasible for practical use in the Almaty Oblast of Kazakhstan only if the appropriate policy framework is provided in the Republic to mitigate agricultural land degradation. In the studies of K. Hermans and R. McLeman (2021), the authors analyse the scheme of organic production, arguing the need for intensive investment in precision and organic farming systems. It is evident that it is renewability that is positioned as the main development of sustainable landscapes, ensuring soil regeneration.

R. Prävālie *et al.* (2021) argue that precision organic farming ensures the balance of the socio-economic system, positively influencing the natural resource potential of land use. Analysing the findings of scientists, it is necessary to focus on the existing potential in Kazakhstan to attract international mechanisms of interaction and targeted investments in the field of agro-ecological projects. Potential long-term benefits of such a development strategy in the context of the Almaty Oblast include increased economic efficiency of the industry and improved environmental parameters, including agro-ecological landscapes. The realisation of such a goal anticipates the expansion of the functionality of the management paradigm in the agricultural sector, taking into account the digital transformation of economic processes. This is convinced by W. Shao *et al.* (2024), also drawing attention to the need to implement an effective monitoring system in the land use sector.

Summarising the research results and conclusions of modern scientists, it is necessary to indicate the main preconditions for improving the methods of rational use in the conditions of land degradation in the Almaty region, Karasai district. Among them: prevention of soil erosion due to ploughing or placement and cultivation of crops on slopes; avoiding soil compaction due to the use of heavy machinery; prevention of soil pollution and chemical poisoning, uncontrolled use of protection products and fertilisers that can change soil pH; maintenance of soil water and chemical regimes to prevent desertification, landslides, mudflows, secondary salinisation; prohibition of destruction of forests and shrub vegetation to preserve soil cover; ensuring bioenergetic regime of soils (devegetation and dehumification).

CONCLUSIONS

The analysis of existing approaches to rational land use in conditions of land degradation shows that the most effective strategy requires a synergy of efforts aimed at increasing the level of functionality of land resources and the ability to regenerate. It is advisable to realize these objectives by optimising management policies. The transformation of land use systems should take place in close interrelation with the technological and organisational-technical optimisation of the main production processes in the direction of the renewability of natural resources. Innovative approaches to land use have the potential to increase the level of efficiency of the agrarian sector, and improve the condition of the local and regional landscape. The concept of improving the state of degraded lands should be based on the synergy of economic efficiency and environmental safety, with the mandatory introduction of modern innovative technological approaches, and information technology for monitoring, diagnostics and forecasting.

Realisation of tasks of sustainable management of landscape complexes in an innovative context implies the use of information monitoring technology, which anticipates diagnosis, genesis and forecasting of the state of the studied ecosystems. Such measures imply programmes for the restoration of ecological functions of natural landscapes, which is an integral part of sustainable development programmes. The study is limited by the possibilities of experimental verification of the obtained results in real socio-economic conditions of development of the Almaty region of Kazakhstan. Unquestioning compliance with the requirements in terms of the maximum load on land resources, bringing the existing norms in organic production to the standards of developed countries, the application of a closed cycle of resource use contributes to the optimization of soil conditions in the Karasai district of the Almaty region. The possibilities of wide implementation of geoinformation technologies, satellite navigation devices and electronic mapping require further research.

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None.

CONFLICT OF INTEREST

None.

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Удосконалення методів раціонального використання в умовах деградації земель в Карасайському районі Алматинської області

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Анотація. Дослідження було спрямоване на ідентифікацію потенціалу сучасних методів раціонального землекористування в Карасайському районі Алматинської області Казахстану з огляду на їх інтенсивну деградацію. Методологія дослідження представлена методами статистичного спостереження, порівняння, аналітично-структурного групування та прогнозування. Проаналізовано пріоритетні цілі модернізації сільського господарства Республіки в технологічному аспекті. Встановлено, що інноваційні підходи до землекористування володіють потенціалом підвищення рівня ефективності аграрної галузі, поліпшення стану локального та регіонального ландшафту. Розроблено концепцію поліпшення стану деградованих земель, що включає систему управлінських заходів і практичних заходів. Доведено, що вона має бути заснована на синергії економічної ефективності та екологічної безпеки, з обов'язковим впровадженням сучасних інноваційних технологічних підходів. Визначено ефективність методів раціонального використання деградованих земель як дієвого інструменту для трансформації аграрної галузі. Запропоновано інтенсифікувати розвиток галузі органічного сільськогосподарського виробництва, яке позиціонується як найбільш щадне для деградованих ландшафтів. Доведено, що реалізація завдань сталого управління ландшафтними комплексами в інноваційному контексті має на увазі використання інформаційної технології моніторингу, що передбачає діагностику, генезу та прогнозування стану екосистем, що вивчаються. Такі заходи дадуть можливість розробляти програми відновлення екологічних функцій природних ландшафтів, що є невід'ємною частиною програм сталого розвитку. Актуалізовано ситуацію в контексті екологізації землекористування в Казахстані, спрогнозовано подальшу деструкцію екосистем аграрних ландшафтів у разі використання агресивних методів обробітку ґрунту. Обґрунтовано необхідність упровадження вдосконалених методів раціонального використання земель, окреслено специфіку впровадження органічних і біологічних технологій сільськогосподарського виробництва, із зазначенням дотичних ризиків і викликів в економічних реаліях Казахстану. У дослідженні обґрунтовано, що застосування інтегрованого управління та екосистемного підходу мають синергетичний потенціал забезпечення раціонального використання земель Алматинської області, Карасайського району в умовах їхньої деградації

Ключові слова: землеробство; сталий розвиток; модернізація; інтенсифікація; органічне виробництво