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Review paper

Ecological and economic aspects of effective use of land resources – potential of Vinnytsia region

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Abstract: The article considers a comprehensive study of the problem of land relations development in the region. It identifies the main directions for their further development, which include improving the legislative framework, economic and monetary valuation of land, leasing land relations and ensuring the formation of a market for agricultural land and ecologically safe land use. The article aims to determine the interrelated components of the organizational and economic mechanism for managing land resources of agricultural enterprises in the context of ensuring land-use efficiency based on the choice of a land-use optimization model. The theoretical and methodological bases for the development of land relations in the conditions of market economy formation are generalized. The directions for improving the ecological status of agricultural land are justified. The state regulation of land relations is analyzed, and ways to improve land legislation are proposed. The directions of the formation and development of the agricultural land market are justified. The ways to improve the ecological condition of the land, taking into account the regional characteristics of the Vinnytsia region, are proposed. To determine the relationship of rational use and reproduction of resources, considering the problems of choosing the optimal strategy for the impact of the economy on the ecologization of land resources, the system of rational use and reproduction of natural resources is developed. The optimization model describing the conditions for the process of stimulating landowners and land users in the direction of protection and rational land use is established.

Keywords: land, monitoring system, land reform, land use efficiency, type of soils

1. Introduction

Land relations have always played a leading role in the life and business of the Ukrainian people. The transformation of the national economy to market conditions caused the corresponding changes in land relations, which were embodied in land privatization, change of land ownership, the formation of responsibility of economic entities for its rational use and protection. Further development and improvement of land relations in agriculture consist of the implementation of a state policy aimed at high-tech and environmentally friendly land use, which corresponds to the regulated, socially-oriented market economy (Soloviy et al., 2005). As a result of the land reform in Ukraine, a radical degeneration in relations on land ownership issues began, a monetary reward for the opportunity to use the land was introduced. Rental relations have developed, and specific prerequisites have been created for the formation of the land market. During the land reform, practically no attention was paid to such issues as quality situation, fertility, and protection of lands (Mikhasyuk and Kosovich, 2002).

Private property is not only a motivation for agricultural producers to increase production and profit, but also forcing their rational use and protection of land. The downward trend in soil fertility has continued due to the decrease in fertilizer application. At the same time, the scope of land and soil protection actions is decreasing every year. It was found that land users use ecological approaches in the farming system, such as the use of phosphorus-mobilizing bacterial and nitrogen preparations, the use of non-sowing soil plowing, peat-based fertilizers, nutrient residues, biological protection methods, and organic humus for plants. However, these measures are applied in insufficient quantities and small areas. The effective implementation of land reform is the first step in Ukraine's exit from the socio-economic and environmental crisis (Harnaga, 2006; Perovich and Hulko, 2019).

The current agricultural crisis, as part of a systemic crisis in the Ukrainian economy, has once again changed the balance of the environmental and economic components of the agricultural system. The specificity of the situation, in this case, is to reduce the necessary level of support for these components. First, almost half of Ukraine's territory is now affected by the degradation processes of agricultural land. Secondly, farms are not able to maintain land use areas due to price disparity, lack of equipment, and working capital, as well as cheap loans (Akulenko, 2003).

Land, as a natural resource, is characterized by qualitative differences affecting the level of fertility (Bober et al., 2016a,b; Calka and Bielecka, 2016; Maleta and Moscicka, 2018; Perovich and Hulko, 2019). Lands can be of the better, medium, and worse quality and the volume of the first two is limited and cannot be increased (Mikhasyuk and Kosovich, 2002). The particular importance of land resources is given by Galushko et al. (2002), who states that it is not just a factor of production, but a good that provides spatial and territorial preconditions for the use of economic and social resource base. An identical interpretation is observed in the works of the famous scientist Fedorov (2003), who argues that land relations are "relations regarding the ownership, use, and disposal of land as the main means of production or spatial means of locating various objects". Sabluk (2006) notes that the concept of ownership, use and disposal should be

supplemented from a legal point of view, in particular, according to the scientist, it would be: "the right to own (consists in the actual ownership of the owner or group of owners), the right to use (consists in the right to extract useful qualities from a thing and receive income) and the right to dispose of (consists in subtraction by all permitted means)".

In accordance with Article No. 1 of the Law of Ukraine "On Land Protection" of 19.06.2003, land resources is the aggregate natural resource of the land surface as a spatial basis for settlement and economic activity, the primary means of production in agriculture and forestry (On Land Protection, 2003).

The problem statement and its relevance lie in need to develop directions for the further development of land relations aimed at achieving effective, environmentally safe land use, improving land legislation, the formation of the infrastructure of the agricultural land market, the inclusion of land value in the economic turnover, which will contribute to the formation of investment-attractive land use, solving economic, social and environmental problems of the village. These provisions can be implemented through the establishment of balanced and consistent state policy and the introduction of adequate financing of land-related activities. The article aims to determine the interrelated components of the organizational and economic mechanism for managing land resources of agricultural enterprises in the context of ensuring land-use efficiency based on the choice of a land-use optimization model.

2. Materials and methods

Agricultural development in the medium-term retrospective tends to decrease (by 8.5 percent), which also affects the proportion of the region in the natural resource potential of Ukraine. However, the localization coefficient of the territory agricultural development is high and is characterized by 11-th place by the territory and 7-th place by the area of agricultural land. Traditionally high is the share of perennial plantations of the region in Ukraine. The existing agricultural potential of the Vinnytsia region is significant in Ukraine, and therefore determines the role and importance of agriculture. Moreover, it allows for solving the whole range of problems of agricultural sector development and placement for the medium and longer-term. The land provision of the population is higher in comparison with other regions: agricultural land per 1 person – 1.06 hectares (on average in Ukraine – 0.87 hectares), arable land per 1 person – 0.96 hectares (on average in Ukraine – 0.68 hectares) (Leonidovich, 2019; Tretyak, 2004). The land fund is characterized by slightly lower forest cover (12.8%) compared with the average for Ukraine, which is 17.3%. The level of plowing of farmland is 85.7%. The soil cover of agricultural land in the Vinnytsia region is not very diverse: 73.5% of agricultural land according to the Institute of Agrochemistry and Soil Science of the Ukrainian Academy of Agrarian Sciences of Ukraine accounts for podzolized soils mainly on loess rocks and clays, 19% are deep and shallow chernozems primarily on loess rocks, 5.8% – meadow-bog, bog, peat-bog, meadow-chernozem, meadow. Vinnytsia region has a total land area of 2649.2 thousand hectares, of which the area of agricultural land – 2020.5 thousand hectares, including arable land – 1732.3 thousand hectares. The plowing of farmland

across the region is over 70% (according to the certificate from the state statistical reporting on the availability of land and its distribution among landowners, land users, lands – FORM 6-zem).

The share of hayfields and pastures is 10.9%. Agricultural land development, which is 78.7% higher than environmental confirmed norms. Vinnytsia region has a powerful natural and agricultural potential, which determines its mission and role in the socio-economic regions of Ukraine. The soils are mainly podzolic (about 65%). In the northeast of the region, chernozems predominate, in the central part – gray, dark gray, light gray soils, in the southeast and Transnistria – chernozems and podzolic soils (Fig. 1) (Leonidovich, 2019).

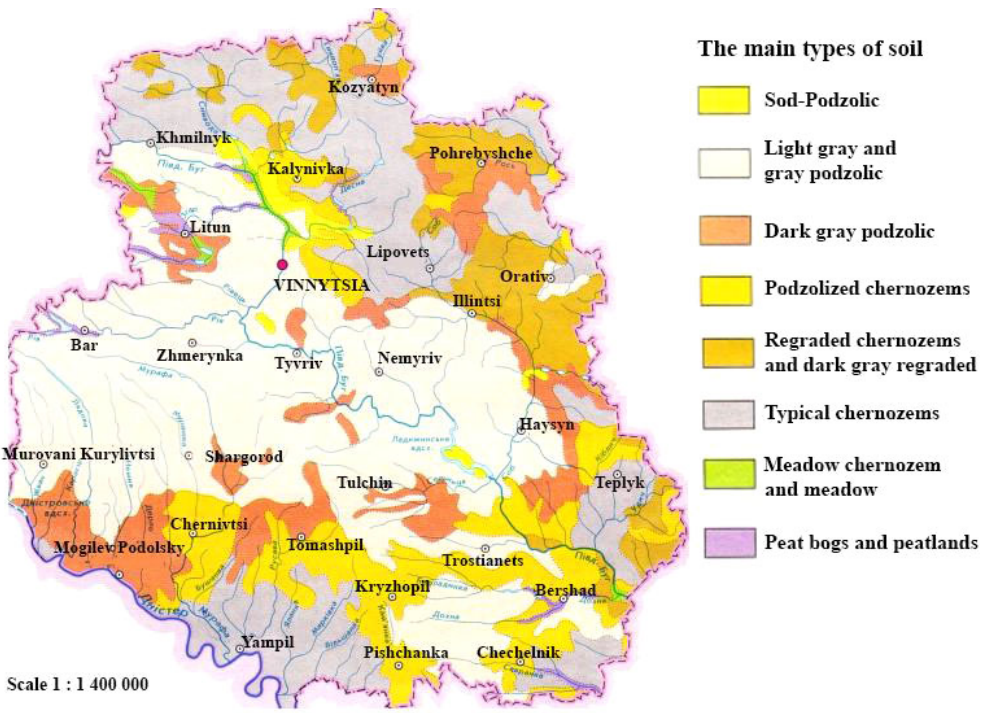

Fig. 1. The soil composition of Vinnytsia region

The intensive development of water erosion processes and waterlogging in the region is due to its topography and geological structure, climate, soil cover, and features of economic activity. About 7.4% of arable land is located on slopes with a steepness of more than 5°, which creates additional problems, as the uncontrolled plowing of lands led to a sharp increase in water erosion processes. The issues of maintaining soil fertility due to destructive phenomena, in particular, the excess of the share of industrial crops in the structure of crops, and the violation of agricultural technology requirements, which leads to wind and water erosion, have become more acute. Arable land is overloaded with grain and industrial crops, which leads to the depletion and loss of productive forces of its arable layer.

The presence of a large number of rivers, 74 reservoirs and 4008 ponds with an area of a water mirror of 12.7 and 19.9 thousand hectares respectively meet the needs of the population for water, however, given the specific features of the landscape, they pose a potential threat of flooding of settlements and fields in the flood period, and can also cause catastrophic flooding in case of dam destruction, especially the Ladyzhyn hydro-recirculation power plant and the Dniester hydro cascade (Leonidovich, 2019). Each land user has the right to choose, use the soil more efficiently, lose more soil due to erosion and have less suitable soil in the future, or take environmental measures, and its amount will not decrease (Harnaga, 2006).

The land conservation activities carried out to prevent and prevent the negative consequences of human activity, namely emissions of mining waste, saturating the atmosphere with fine clastic and gaseous waste – dust, gases, which ultimately leads to environmental pollution, climate change, damages flora and fauna is of great importance in the economic and ecological regulation of land relations. In this case, it is necessary to carry out activities aimed at eliminating the consequences of the works mentioned above. Such measures include reclamation of mining areas and engineering structures of the urban landscape to bring it into a suitable condition for further human use; restoration (partial or full) of the natural relationships between the geological environment, the biosphere, the hydrosphere, and the atmosphere. An equally important area of protection of the geological environment is the prevention and elimination of the harmful effects of natural geological processes, the protection of the environment from natural disasters – hurricanes, typhoons, mudflows, floods, landslides, volcanic eruptions, earthquakes, etc. From the above, it is evident that geologists, hydrogeologists, geochemists, geophysicists, and mining engineers should be primarily involved in protecting the geological environment. The efficient use of land is formed by three interconnected components, each of which ensures the implementation of certain public functions and requires the application of a set of relevant land protection measures (Fig. 2) (Gasiorowski and Bielecka, 2014; Novakovska, 2009).

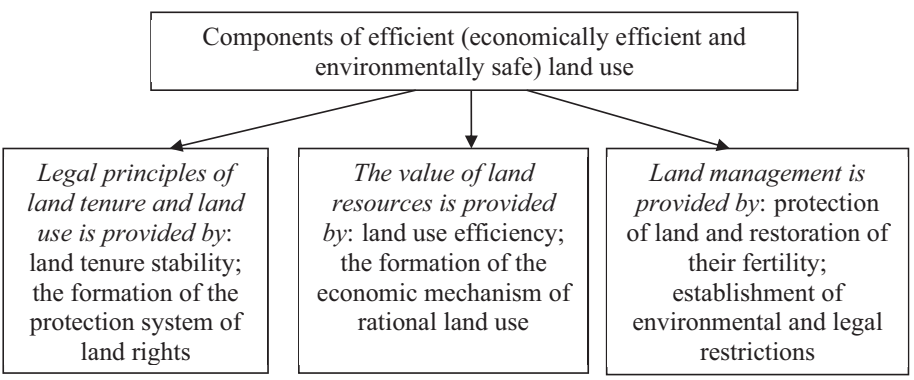

Fig. 2. Components of effective land use

Due to environmentally unjustified industrial activity and lack of proper environmental action, large industrial regions have been formed in Ukraine, which today belong

to the disaster zones (Khvesik et al., 2004). Despite the ecological status of agricultural lands and the nature of their use, it is necessary to significantly strengthen the control and stimulating functions of the state for the rational use and protection of agricultural land, as well as the compliance with environmental requirements by each agricultural producer (Palamarchuk et al., 2004). Such stable systems ensure the steady-state of the ecological and economic policy as political, legislative, tax (the existence of a taxation system provides the constant flow of funds to budgets of all levels from environmental protection), the optimal and periodic level of investment (increasing investor interest in investing in the development of land resources), innovation policy (the use of non-waste production technologies). Efficient use of land resources means achieving the economically viable and environmentally safe level of return per unit of resources, compliance with the balance and the desired level of nutrients in the soil, preventing different types of erosion, the introduction of energy-saving and environmentally friendly technologies of soil cultivation and crop production, scientifically-based reclamation work conducting (Gritsenko, 2008). World historical experience shows that market relations are the most favorable for the efficient use of productive resources, including land resources. Based on the research of Ukrainian and foreign scientists, it should be noted that the problem of development of land relations differs in complexity because land relations are not permanent and are subject to constant changes.

The practice and historical experience of land reforming clearly show that the prudence and validity of any transformation in land relations is the key to effective agricultural management. The change of land ownership is considered at the present stage as the main task of land reform. Land ownership determines the content of land relations in the system of socio-economic relations. The reform of land relations in current conditions should be carried out on a democratic basis with the participation of the population living in this territory (Landel and Migolinets, 2010). Their essence is as follows:

- in the process of land redistribution it is necessary to create a reserve for the development of farming, meeting the needs of demographic change in the countryside, managing migration of the population;
- the ultimate goal of land reform is to establish ownership of land by citizens, public organizations, the state, and to create efficient, market-based agricultural enterprises on this basis;
- land relations reform is carried out by denationalization and privatization of land plots, taking into account land plots, which, in accordance with the law, remain under state jurisdiction.

The content of economic incentives for the rational use and protection of land is disclosed in Art. 205 of the Land Code of Ukraine (Tretyak, 2004), which provides for a number of measures to ensure subjects of ownership of land and rational land use, namely: the provision of tax and credit benefits, exemption from payment for the property, allocation of funds and compensation from state or local budgets. It should be noted that these mechanisms should operate comprehensively, implementing consistent state management of natural resources, including rational land use, attracting economic incentives to the environmentally oriented activities of various business entities. The current low financial status of agricultural land use is due to the following factors:

– a significant number and area of unclaimed shares that are either not used or used without proper accounting and control;
– insufficient structuring of land and development of various forms of economic management in the agricultural sector;
– a significant amount of cases of illegal land occupation, which are not subject to control and accounting for their use.

The main ways to improve the ecological level of agricultural land use are as follows:

– increase productivity and environmental sustainability of crops;
– ecologically safe and economically efficient use of natural properties of agricultural lands;
– effective, timely organization of ecological farming;
– creation of favorable economic and ecological conditions of agricultural production;
– the proportional relationship between the implementation of integrated measures for the protection of land and their use with maximum benefit.

In our opinion, it would be rational to introduce the concept of "ecological and economic equilibrium" – this is a balance of environmental (variable natural components that form the natural environment) and economic (variables depending on landowners and land users) factors provides long-term rational use of land resources. The imbalance in the composition of the land fund weakens the ecological condition of the land and the entire efficiency of the use of agricultural land in the region. In our opinion, the main economic problems of ecology are solved by the following tasks:

1) the existence of the interdependence between economic and natural systems, as well as considering the elements of their change;
2) the formation of factors of influence on improving human well-being due to the sustainability of the ecosystem;
3) the formation of indicators that reflect the real and current state of the environmental situation, the formation of the influence of economic, motivational factors on it;
4) the development of new processes and the improvement of existing regulatory methods of influence.

At the present stage of development of the agrarian sector of the economy, it is crucial to develop a program of action for the land reform completion. One of the outstanding essential tasks is the introduction of a full and transparent land market in Ukraine, which is a key to improving the efficiency of agricultural production and the basis for the formation of economic interest in the potential owner. The relevance of the question raised is not in doubt since we are talking about the formation of a peasant as a full-fledged owner of a land plot, as well as the recognition of land as capital and the inclusion of its value in economic turnover. The problems of rational use of natural resources and environmental protection imply the application of a set of measures, which include the effective use of financial instruments together with socio-political, legal, psychological, and ethical methods (Tretyak, 2004).

3. Results

In the period of market relations formation, the indicators of economic and normative monetary valuation of agricultural lands require clarification. As a result of the studies, the adjustments to the indicators of economic valuation of the land under conditions of withdrawal of unproductive and degraded lands based on the classification of the suitability of soils for growing grain crops were made. This will increase the assessment indicators (both economic and normative monetary), which will contribute to improving the environmental sustainability of agricultural landscapes, as well as an objective assessment of land.

As a result of studies, it was found that the main measures to increase soil fertility in the region are the rational use of mineral and organic fertilizers, the introduction of the practice of applying biological fertilizers, sowing green crops, the correct alternation of crops in crop rotation, cultivation of perennial tight bush plants, liming of acidic soils, widespread implementation of measures to control water and wind erosion (forest reclamation, tinning, etc.). The removal of low-productive lands from intensive cultivation, their transfer to natural fodder land and afforestation, conservation of unsuitable soils for agricultural use will help to stop the degradation processes and the reproduction of natural agro landscapes.

Performing these works requires considerable financial costs. Therefore, it is advisable to conduct them in stages, which will increase the efficiency of the conservation and land reclamation measures in the Vinnytsia region and rationally distribute the financial resources of state and local budgets, as well as the funds of landowners and land users. The primary source of forestry improvement should be funded from the state and local budgets. Tinning operations should be financed mainly from the funds of landowners and land users. In order to determine the relationship of rational use and reproduction of resources, considering the problems of choosing the optimal strategy for the impact of the economy on the ecologization of land resources, the system of rational use and reproduction of natural resources is developed (Fig. 3).

Studies have shown that one of the essential directions for improving land relations is to increase the environmental sustainability of agro landscapes, which requires expanding the area of natural fodder land and forests by reducing degraded and unproductive arable land. To this end, in the Vinnytsia region, it is proposed to transfer 400.3 thousand hectares from the area of arable land to natural fodder land and 60 thousand hectares for afforestation. Work on the creation of protective forest stands needs to be performed on an area of 26.5 thousand hectares, 527.9 thousand hectares are required for liming, including 105.6 thousand hectares annually. The basis of the financial system of environmental protection activities should be rent payments for the use of natural resources, and funds that abstain from rent should have a well-directed and clearly defined ecological character. The process of stimulating landowners and land users in the field of protection and rational land use is conditioned by the use of the following optimization models of land use:

$$C_l < \left(P + T_\mathrm{b} + K_\mathrm{b} + A_\mathrm{p}\right) \tag{1}$$

where C_l is the land users' costs for land management, land improvement, and land conservation activities, P is the profit from land management and use of improved land, T_b is the tax benefits, K_b is the credit benefits and A_p is the price allowances.

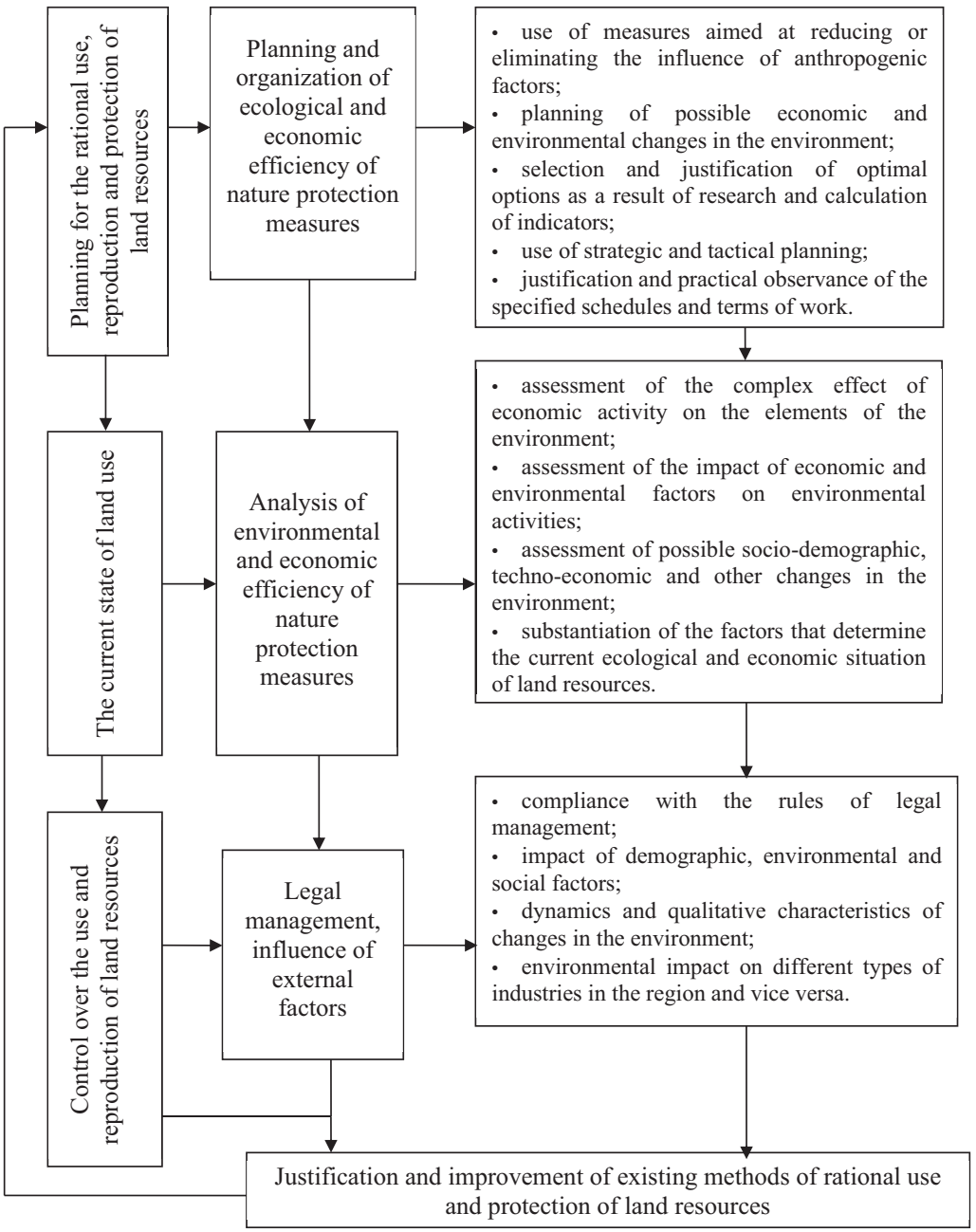

Fig. 3. The system of rational use and reproduction of natural resources

Elements of this model increase the profit remaining at the disposal of landowners and land users, in the case when they provide effective environmental protection.

$$C_l < (U_o + P_o + W_d + F + T_a) \tag{2}$$

where U_o is the charges for overtime use of land (plowing), P_o overtime pollution charges, W_d is the waste disposal charge (agricultural land clogging), F is the fines and T_a is the additional taxation.

Elements of this model reduce the profit remaining at the disposal of landowners and land users, in the case when they provide effective environmental protection. The mechanism for ensuring the development of sustainable use of agricultural land comprehensively covers the following components: environmental, economic, institutional, information, social and political, and legal.

In the context of such a mechanism, effective levers, and tools that will ensure the sustainable use of agricultural land are:

- economic incentives for landowners and land users to increase land fertility relative to the baseline, when obtaining land for ownership or use;
- financial responsibility for changing the quality of soil;
- improvement of environmental insurance in terms of ensuring maximum compensation for damage in case of damage to agricultural land.

In our opinion, the prospect of economic regulators functioning will allow us to move to a higher level of agricultural land efficient use with maximum consideration of land and social interests. Therefore, the process of rational land use must ensure compliance with the requirements of the legislation and obtain the most significant economic effect from the cultivation of crops that can give a particular plot of land, taking into account its territorial location. The next component of the financial mechanism of land resources may be investments, the purpose of which is to prevent damage to the environment, as well as compensation for environmental damage resulting from accidents, disasters, and other unforeseen releases of hazardous substances (Bilskiy et al., 2014).

4. Discussion

In our opinion, the main economic problems of ecology can be solved with the following tasks:

1) the existence of interdependence between economic and natural systems, as well as considering the elements of their change;
2) formation of factors influencing the improvement of human well-being due to the sustainability of the ecosystem;
3) formation of indicators that would reflect the real and current state of the environmental situation, the formation of the influence of economic and motivational factors on it.

The promising ways of increasing the efficiency of land use of agricultural enterprises on the example of land use optimization models are given. It is necessary to significantly strengthen the stimulating functions of the state concerning the rational use

and protection of agricultural land, compliance with environmental requirements by each farmer. In the period of formation of market relations, the indicators of economic and normative monetary valuations of agricultural lands need to be clarified. It is necessary to increase state control over farmers' compliance with land legislation and environmental standards, introduce official reporting of statistics on the required number of land protection and soil protection measures, increase the desire for environmentally friendly techniques in land use. The imbalance in the composition of the land fund weakens the ecological situation of the land and the overall efficiency of agricultural land use in the Vinnytsia region.

Studies have shown that one of the ways to improve land relations is to increase the ecological sustainability of agricultural landscapes, for which it is necessary to increase the area of natural forage lands and forests by reducing degraded and unproductive arable land. The problem of development of land relations is particularly difficult, primarily because land relations are not sustainable and are undergoing constant change. It is necessary to create a system of continuous monitoring of entities whose activities are related to the land fund of the agricultural sector with other components of the environment, which should be the basis for developing the relationship between ecology and economy. Insufficient funding of environmental measures and environmental programs by the state is insufficient. During the land reform, almost no attention was paid to such issues as quality, fertility, and land protection. The study found that the amount of measures for land conservation and soil protection is continuously decreasing every year.

The problems described in the article are very relevant. Scientists from different countries find different ways to solve these problems. Kuryltsiv et al. (2018a) describe in detail the current conditions, process, and consequences of the land reform in Ukraine. Scientists determine their impact on the support for sustainable land management and offer the measures of sustainable management, present the programs of the land organization, technical and economic reasoning for the use and protection of land in administrative-territorial units, land development projects, as well as environmental and economic arguments for crop rotation and land management, implemented within work projects of the land organization at regional, provincial and local levels.

In Kuryltsiv et al. (2018b), the main stages of establishment of amalgamated territorial communities, conditions of the existing, and future formation of them are highlighted. Authors argue that financial decentralization and cession of agricultural land parcels of state ownership to communal holding are the key to the efficient development of corresponding territories. Moreover, an algorithm of the cession of agricultural lands of state ownership to communal possessing by corresponding amalgamated regional communities are presented. Authors declare that such a step will supply the formation of clear and transparent revenue of local budgets in terms of payment for lands and will stimulate economic development of amalgamated territorial communities.

The experience of solving such problems in southern Poland (the Małopolska Province) and northern Hungary (the Pest County) is described in (Cegielska et al., 2018). Authors have analyzed changes in land use and land cover using GIS and sta-

tistical methods, based on cadastral data, statistical data, and CORINE Land Cover data and proposed the new method aimed to perform a synergy analysis carried out according to the 'top-down' principle. As a result of the study, the authors identify and assess the ongoing land use and land cover changes and compare them in the assumed field of research. The land cover changes in the Pest County and the Małopolska Province indicate a decrease in agricultural areas and an increase in artificial surfaces, forest and semi-natural areas with the change in Poland being more intensive than that in Hungary.

A more detailed study in five administrative regions of Poland was conducted by Noszczyk et al. (2020) as a result of which, the changes in surface areas of individual land-use types were analyzed. Agricultural land, forest land, built-up and urbanized land, and wasteland were used as variables for annual time series. In this study, a Mann-Kendall (MK) test and Cox-Stuart (CS) test were used for the monotonic trend and the autoregressive-moving-average model.

One of the critical unresolved tasks is the introduction of a full and transparent land market in Ukraine, which is the key to improving the efficiency of agricultural production and the basis for the formation of economic interest in the potential owner. One of the main reasons for the slow development of land relations in Ukraine is the underdeveloped and contradictory legal framework that regulates the rights and responsibilities of state bodies and participants in land relations. Another reason for the slow development and establishment is the significant shadowing of the land market.

Establishing a transparent land market is not only a sale, but it is also primarily an opportunity for effective management, one of the options of which is the transfer of land for long-term leases. The land market in Ukraine should be regulated by the state, the main directions of which should be:

- organization of the land market based on current legislation and by-laws;
- identification of land market infrastructure entities;
- determination of mechanisms for acquisition and alienation of land rights;
- determination of the powers of executive bodies and local self-government in the sphere of activity on the land market;
- determining the peculiarities of the circulation of agricultural land;
- determination of the methods for transferring land from one owner to another; determination of the procedure for receiving and recovering losses on the land market;
- use of funds from the sale of land.

For further development, the state must create appropriate conditions for people. Opening a transparent land market in Ukraine is the primary factor. We have the prospect of growth but on the condition of establishing clear rules. The introduction of a full-fledged land market will solve a number of essential problems of our time: the creation of jobs in rural areas, increasing the investment attractiveness of agriculture, establishing the objective market value of agricultural land, but most importantly, the implementation of private property rights by all subjects of land relations.

The transparency of land relations will be a serious blow to corruption, which will certainly affect the place of the Ukrainian state in various international ratings (including Doing Business) regarding the state of our economy, investment attractiveness, and

the like. World experts are already telling us about this. Thus, Ukraine's economy will receive a new impetus in its development, and investment inflows will increase significantly.

5. Conclusions

The transition of the national economy to market economic conditions led to corresponding changes in land relations in the Vinnytsia region, which were embodied in the processes of land privatization, changes in land ownership, the formation of responsibility of economic entities for its rational use and protection. It is also advisable to create permanent monitoring of objects whose activities are related to the land fund of the agricultural sector with other components of the environment. The creation of the registry and the implementation of ongoing monitoring will be the starting point, the basis for the development of the relationship ecology-economy.

According to the research results, it was proved that in this way, state bodies should introduce a transparent system of control over the state of land use and use and their quality characteristics. It is necessary to increase state control over the implementation of environmental and land laws, ecological standards, indicators, and standards by land users; introduce official statistics reporting on the required number of land conservation and soil protection measures, increase the use of environmentally friendly techniques of land use. Therefore, it is necessary to introduce a control and monitoring system, systematically inspect agricultural land. As a result of the research, it was concluded that the financing of environmental measures and environmental programs in the state is insufficient. One of the important unsolved problems of reforming is the introduction of a full and transparent land market in Ukraine, which is the key to increasing the efficiency of agricultural production and the basis for generating economic interest of a potential owner.

Author contributions

Y. H. and V. S. made critical revision and final approval of article, O. H. was responsible research concept and design, Y. K. and L. V. were responsible for data analysis and interpretation.

Data availability statement

The processed data required to reproduce these findings cannot be shared at this time as the data also forms part of an ongoing study.

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References

Akulenko, V.L. (2003). *Economical-organizational grounds of the ecological-economical development of the region*. PhD thesis (econ.), Sumy: Sumy State University.

Bilskiy, I., Dudyak, R., Ivanov, A. and Magiyovich, I. (2014). Investigation of investment attractiveness of foreign capital in the agricultural production sector in Lviv region. Bulletin of the Lviv National Agrarian University: Ekonomika: APK Economy, 21(1), 188–194. September 2020, http://nbuv.gov.ua/UJRN/Vlnau_econ_2014_21%281%29_38.

Bober, A., Calka, B. and Bielecka E. (2016a). Synthetic Landscape Differentiation Index a Tool for Spatial Planning. In 2016 Baltic Geodetic Congress (BGC Geomatics). Gdansk, Poland, 2016, pp. 234–238. DOI: 10.1109/BGC.Geomatics.2016.49.

Bober, A., Calka, B., and Bielecka, E. (2016b). Application of state survey and mapping resources for selecting sites suitable for solar farms. Inf., Geoinform. and Remote Sens. Conf. Proceedings, SGEM 2016, vol I. Book Series: *International Multidisciplinary Scientific GeoConference-SGEM* (pp. 593–600).

Cegielska, K., Noszczyk, T., Kukulska, A., Szylar M., Hernik, J., Dixon-Gough, R., Jombach, S., Valánszki, I. and Kovács, K.F. (2018). Land use and land cover changes in post-socialist countries: Some observations from Hungary and Poland. *Land Use Policy*, 78, 1–18.

Calka, B. and Bielecka E. (2016). The Application of Geoinformation Theory in Housing Mass Appraisal. In 2016 Baltic Geodetic Congress (BGC Geomatics). Gdansk, Poland, 2016, pp. 239–243. DOI: 10.1109/BGC.Geomatics.2016.50.

Fedorov, M.M. (2003). Organizational and economic prerequisites for the formation of the agricultural land market. *The Economy of Agro-Industrial Complex*, 1, 25–31.

Galushko, V.P., Bilik, Y.D. and Danilenko, A.S. (2002). Land market formation in Ukraine. In Danilenko A.S. and Bilik Y.D. (Eds.). Kiev: Urozhay.

Gasiorowski, J. and Bielecka, E. (2014). Land fragmentation analysis using morphometric parameters. In 9th International Conference on Environmental Engineering (ICEE). Vilnius, Lithuania, 2014. DOI: 10.3846/enviro.2014.205.

Gritsenko, A. (2008). *Institutional architectonics and the dynamics of economic transformation*. Kharkiv: Fort.

Harnaga, O.M. (2006). *Ecological and economic principles of agricultural land market formation*. Rivne: National University of Water and Environmental Engineering.

Khvesik, M.A., Gorbach, L.M. and Kulakovsky, Yu.P. (2004). *Economic and Legal Management of Environmental Management*. Kyiv: Condor.

Kuryltsiv, R., Hernik, J. and Kryshenyk, N. (2018a). Impact of land reform on sustainable land management in Ukraine. *Acta Sci. Pol. Formatio Circumiectus*, 17(2), 105–115. DOI: 10.15576/ASP.FC/2018.17.2.105.

Kuryltsiv, R., Hernik, J., Kryshenyk, N. and Zhydovska N. (2018b). Land inventory as the instrument for development of amalgamated territorial communities in Ukraine. *Acta Sci. Pol. Formatio Circumiectus*, 17(4), 97–108. DOI: 10.15576/ASP.FC/2018.17.4.97.

Landel, M.A. and Migolinets, M.I. (2010). Assessment of investment attractiveness of the Carpathian region enterprises. Investment: practice and experience, 9, 14-18. September 2020, http://nbuv.gov.ua/UJRN/ipd_2010_9_6.

Leonidovich, S.V. (2019). Natural Resources and Resources of the Vinnytsia Region. Vseosvita, September 2020. https://vseosvita.ua/library/prezentacia-prirodni-umovi-ta-resursi-vinnickoi-oblasti-131136.html.

Maleta, M. and Moscicka, A. (2018). Selection and significance evaluation of agricultural parcels determinants. *Geodesy Cartogr*., 67(2), 239–253. DOI: 10.24425/gac.2018.125473.

Mikhasyuk, I. and Kosovich, B. (2002). *Management of land relations*. Lviv: Ivan Franko Lviv National University.

Noszczyk, T., Rutkowska, A. and Hernik, J. (2020). Exploring the land use changes in Eastern Poland: statistics-based modeling. *Hum. Ecol. Risk Assess.: An International Journal*, 26(1), 255–282. DOI: 10.1080/10807039.2018.1506254.

Novakovska, I.O. (2009). *Ecological and economical basis of rural landusing transformations in market conditions*. PhD thesis (econ). Kyiv: Council for Productive Forces Studying, National Academy of Science of Ukraine.

On Land Protection. (2003). Law of Ukraine on June 19, 2003, No. 962-IV Document 962-IV, valid, current version. Revision on December 18, 2017, on the basis – 2059-VIII. Available at: http://zakon4.rada.gov.ua/laws/show/962-15/page2.

Palamarchuk, V.O., Mishenin, E.V. and Korenyuk, P.I. (2004). *Ecological-economic and social essays on environmental issues*. Dnipro: Porogi.

Perovich, L. and Hulko, O. (2019). Monitoring the actual ecological end economic situation of agricultural land use in Ukraine. *Geodesy Cartogr*., 68(2), 349–359. DOI: 10.24425/gac.2019.128464.

Sabluk, P.T. (2006). *Development of land relations in Ukraine*. Kyiv: Kyiv National Economic University: National Institute of Agrarian Economics National Science Center.

Soloviy, I.P., Ivanyshyn, O.T., Lavnyy, V.V., Turchyn, Yu.I. and Chaskovskyy, O.H. (2005). *Land use: environmental and economic problems, conflicts, planning*. Lviv: Afisha.

Tretyak, A.M. (2004). *Economics of land use and land management*. Kyiv: LLC TSZRU.