# Evaluation of Economic and Environmental Changes for the Use of Land Resources in the Sustainable Development Context

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**Abstract:** One of the main principles of Ukraine's domestic and foreign policy is the preservation of the environment and its components, which is vital for human existence, as well as its present and future generations. Land resources available to us are limited. Thus, we have to acknowledge their importance for human survival and awareness of the rate, at which people are depleting and destroying them, which has formed a completely new paradigm about the role and importance of planning and managing land resources and land use. The research aims to identify the factors that have the greatest impact on the development of soil degradation and pollution, as well as implement priority measures in the land management system, namely reduced areas with the use of pesticides and agrochemicals, which in turn would improve agrarian ecosystems, create conditions for the restoration of biodiversity in the agrarian sphere, would help prevent degradation and chemical contamination of soils. The implementation of suggested measures is aimed at improving the quality of the natural environment and human living conditions. The study of changes in the land productive potential depending on production intensification factors was carried out using dispersion and correlation-regression modeling of the agricultural land unit profitability.

**Keywords:** Profit, fund provision, land degradation, soil erosion, land conservation, ecological optimization, land quality, production intensity.

## INTRODUCTION

Currently, climate change and depletion of natural resources urge mankind to consider the priority of reducing resource consumption, transitioning to renewable energy sources, low-waste and clean technologies and building a waste management system to comply with European standards. This is declared in the 17 Sustainable Development Goals (UN Summit on Sustainable Development, 2015), which aim to protect the planet, overcome poverty, and ensure peace and prosperity for all mankind. These are important steps for the state that formulates effective policy, creates a regulatory framework, and opens information, and business is ready to accept these regulatory changes and adhere to the principles of sustainability in its work.

Therefore, an important role is played by the Association Agreement between Ukraine and the EU, to follow to which, Ukraine has undertaken to harmonize domestic legislation with the European legislation in terms of sustainable development: in Part 2 of Art. 289 it is stated that "The Parties recognize the importance of taking full account of the economic, social, and environmental interests not only of their respective populations but also of future generations and ensure that economic development, environmental, and social policies are supported jointly".

Ukraine, like other UN member states, has joined the global process of sustainable development. During 2016–2017, a large-scale process of adapting the Sustainable Development Goals (SDGs) to the Ukrainian context continued. The creation of a national strategic framework for Ukraine for the

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period up to 2030 was based on the principle "to leave no one behind". Each global goal has been revised, taking into account the features of national development. The result of this work was the national system of CSW, which consists of national development tasks with appropriate indicators.

The search for ways to solve environmental problems in conjunction with social and economic aspects has contributed to the spread of the sustainable development concept.

Korovii Ya. V. proposed an algorithm for modeling the impact of innovation in the agribusiness sector to ensure global sustainable development, which involves the use of the first stage of cluster analysis to determine the most successful group of countries in terms of effective innovation policy in the agricultural sector and its impact on the sustainable development; the second stage implies the identification of approaches to the formation of public policy in this group of countries, aimed at supporting the development of innovative transformations in the agribusiness sector, which ensures their relevance to the challenges of global sustainable development; on the third stage there is the modeling of the optimal level of costs for innovations to maximize the indicators of sustainable development using the method of system-dynamic modeling.

The authors Moroz V. and Dyma V. summarized the impact of digital transformation on the formation of a green economy in Ukraine, analyzed the state policy of digitalization of public administration in the economic sphere. It is proved that the basic principles of the digital economy as a specific economic system based on the activities of Internet intermediaries acting as Internet platforms, complement the traditional economy and accelerate the processes of production, distribution, exchange, and consumption.

Mamonov K., Kondrashenko E., Radzinskaya Yu., and Myronenko M. proposed to apply the method of mathematical modeling based on correlation and regression analysis, which will predict the integral indicator of territorial development of the land use in regions depending on spatial, urban, environmental, and investment factors. Within the framework of mathematical modeling, models of the influence of factors on the integrated indicator of sustainable land use development have been developed.

The deterioration of the environmental situation in rural areas deserves special attention. The main reasons for this are the lack of advanced technologies of agricultural production; non-compliance with scientifically sound crop rotations with a predominance of monocultures (especially sunflower, corn, and rape) at many enterprises, especially agricultural holdings; low rates of application of organic fertilizers; excessive use of synthetic plant protection products and mineral fertilizers; lack of technologies to combat erosion, acidification, salinization, and man-made soil pollution.

Currently, scientific views on the idea of achieving a neutral level of land degradation are being presented in foreign publications. The purpose of this concept is to support the productivity not only of land resources but also of terrestrial ecosystems and related ecosystem functions and services to meet the needs of present and future generations. Neutrality is the absence of a net loss of terrestrial natural capital to comply with the reference state or baseline. Planning for a neutral level of degradation involves designing the probable cumulative effects of land use and land management and later balancing the expected losses with measures to achieve equivalent benefits. Balancing is recommended within certain types of land. Actions to achieve a neutral level of degradation include sustainable land management practices that avoid or reduce degradation, as well as restore degraded land. Thus, management decisions in land use must adopt a hierarchy of "avoid - reduce – restore", which clearly defines the priorities in planning measures to achieve a neutral level of land degradation. Such planning should take into account the natural conditions and social and economic linkages within specific areas to determine the best environmental solutions for increasing the resilience of ecosystems. In general, the implementation of this concept takes place at the landscape level through integrated land use planning, while the results are assessed at the regional and national levels.

Therefore, Ukraine's sustainable development includes such guidelines as well-being and health of the population provided by innovative economic development, which is built on the rational use of natural resources. Today, scientists face the problem of developing proposals to reduce soil contamination with toxic substances, including heavy metals, restore soil fertility and improve the quality of vegetable raw materials. Soil degradation has been an inevitable companion of mankind for many centuries. The use of natural soil fertility without trying to restore it is a sign of a low level of development of agricultural culture and society as a whole.

## METHODOLOGY

The article is based on the theoretical and methodological data of a comprehensive study of the economic and ecological consequences of the agricultural land use functioning using modern methods of studying phenomena and processes. They are: monographic analysis as consideration and generalization of the theoretical foundations of greening and its impact on the agricultural land use formation; systematisms and comparative analysis as application during ecological and economic assessment of agricultural land; statistical generalization to determine and compare the effectiveness of agricultural land use; analytical method to study trends in the intensity indicators dynamics of land resources use; dispersion and correlation-regression modeling as the study of changes in the land productive potential depending on the production intensification factors, modeling of the agricultural land unit profitability. To study the quantitative dependence of the agricultural land profitability on the qualitative composition of land, fund provision and capital equipment of enterprises, a model of a three-factor dispersion complex was calculated according to the following parameters: V - profit per hectare of agricultural land, UAH; A – land quality, score; B – the cost of the main production assets per 1 hectare of agricultural land, UAH; C – cost of basic production assets based on one average annual employee, UAH. The calculation of the model is based on the combined grouping of the investigated factors for 55 agricultural enterprises.

## RESULTS AND DISCUSSION

The economy transformation in the ecological direction laid the foundations for the sustainable development concept. The latter became an important milestone in the integration of environmental problems into plans for socio-economic development and in raising awareness of the negative consequences caused by the number of industries production on the environment and society.

In the conditions of the ecological situation aggravation, the ecological and economic efficiency of land resource management should be considered in the aspect of their rational use and natural condition preservation. This actualizes the problems of increasing the efficiency of the land resources use, taking into account their qualitative condition, initiates the development of theoretical and practical foundations of rational land use. With the development of new management forms and territory organization methods, the issue of establishing criteria for determining the rationality degree of in the land resources use, taking into account economic and ecological criteria, is brought to the foreground.

In the theory of effectiveness, the concepts of "criteria" and "indicators" are distinguished. Efficiency criteria characterize its qualitative side, compliance of the activity result with the goals that determine this activity. The quantitative expression of this correspondence degree is seen in the performance indicators. Such indicators can be the return of each hectare, the reduction of production costs, as well as income indicators and increased soil fertility. In view of the public interest, the criterion for the efficiency of land use is to meet the population needs in agricultural products through domestic production.

Ukraine's agribusiness is a key powerhouse of the Ukrainian economy and its leading link making a significant contribution to gross value added (10.1% of GDP in 2018) and forming almost half of the country's exports (44.3% of exports of goods in 2019). One of the factors in the development of agricultural production and food processing was the active modernization of production processes. Thus, in 2019, capital investment in agriculture increased by 2.0 times compared to 2015. Accordingly, the degree of depreciation of fixed assets in agriculture in 2018 compared to 2016 decreased by 1.9 percentage points, from 37.3% to 35.4%, and in the food industry – by 2.8 percentage points, from 51.1% to 48.3%, respectively. More rational use of available resource potential combined with the processes of technological renewal has contributed to the growth of labor productivity in agriculture. Thus, in 2018, labor productivity in agriculture amounted to 10.89 thousand US dollars per employee, which is 25.5% higher than in 2015 and exceeds the target of 2020.

According to the data of the State Statistics Service of Ukraine in 2021, the volume of agricultural products in actual prices, according to calculations, amounted to 885,627 million UAH. The crop production index in 2021 is -122.6% compared to 2020, including enterprises - 127.8%, households - 111.4%, in the field of animal husbandry, the production index in 2021 compared to 2020 - 95.4%, including enterprises - 98.0%, households - 92.4% (table **1**).

**Table 1. Agricultural Products Indices (Percentage to the Previous Year).**

| | 2019 | 2020 | 2021 |
|---|---|---|---|
| **Agricultural products:** | **101.4** | **89.9** | **116.4** |
| agricultural enterprises | 102.7 | 88.0 | 122.3 |
| households | 99.1 | 93.6 | 105.6 |
| **Crop production** | **101.8** | **87.9** | **122.6** |
| agricultural enterprises | 102.5 | 85.8 | 127.8 |
| households | 100.2 | 92.8 | 111.4 |
| **Animal husbandry** | **100.2** | **97.5** | **95.4** |
| agricultural enterprises | 103.8 | 99.3 | 98.0 |
| households | 96.7 | 95.6 | 92.4 |

Source: according to Ukraine in numbers. 2022. Statistical compendium 2021. [Electronic resource]. Available at: https://ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/08/zb_

Taking into account this situation regarding the production of agricultural products and the provision of food to the population of Ukraine, it is necessary to pay attention to the constant growth of agricultural products share in the exports structure. In 2021, Ukraine increased foreign trade turnover of agricultural products and food. According to the results of 2021, agriculture contributed the highest percentage to GDP among all branches of economy - more than 10 %. Agrarian food products also account for the largest percentage of total exports of Ukraine - about 41% per year. Agriculture showed the highest increase in production in 2021 – 14.4%. According to the results of the year, production at agricultural enterprises has increased by 19.2%. At the same time, agricultural sector products were exported in the amount of $27.7 billion (or 40.7% of the total export of goods from Ukraine), which is 25% more than in 2020. The most important parts of food and agricultural products export in 2021 remained grain crops, oil, oilseeds and cakes, solid waste from the extraction of vegetable fats and oils.

To a large extent, the condition of the soil cover, in particular the possibility of reproducing its fertility, depends on the structure of the cultivated areas. The analysis of the agricultural crops spread dynamics in our country shows that the sown areas of cereals and legumes and vegetables in the open ground are increasing, while the rest of the crops are decreasing (Tables **2**, **3**).

**Table 2. The Harvest Area for Collection of Agricultural Crops (Thousand Hectares).**

| Agricultural Crops | 2019 | 2020 | 2021 |
|---|---|---|---|
| Cereals and legumes | 15292 | 15283 | 15948 |
| Sunflower | 5959 | 6481 | 6665 |
| Sugar beet | 221 | 220 | 227 |
| Potato | 1309 | 1325 | 1283 |

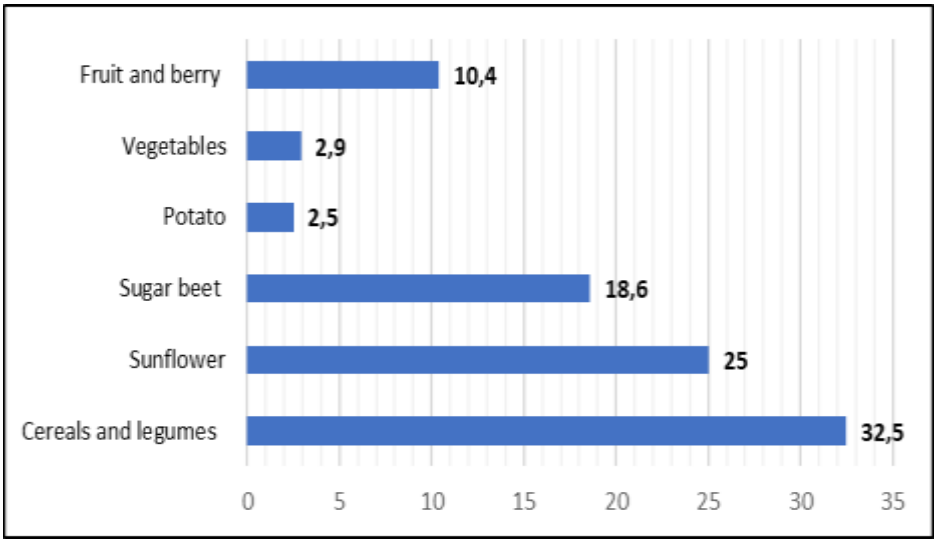


**Fig. (1).** Increase, decrease (-) in the production of major agricultural crops in 2021 (percentage to the previous year).

| | | | |
|---|---|---|---|
| Vegetables | 452 | 465 | 461 |
| Fruit and berry | 196 | 191 | 191 |

Source: according to Ukraine in numbers. 2022. Statistical compendium 2021. [Electronic resource]. Available at: https://ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/08/zb_

**Table 3. Agricultural Crops Production (Thousand Tons).**

| Agricultural Crops | 2019 | 2020 | 2021 |
|---|---|---|---|
| Cereals and legumes | 75143 | 64933 | 86010 |
| Sunflower | 15254 | 13110 | 16392 |
| Sugar beet | 10204 | 9150 | 10854 |
| Potato | 20269 | 20838 | 21356 |
| Vegetables | 9688 | 9653 | 9935 |
| Fruit and berry | 2119 | 2024 | 2235 |

Source: according to Ukraine in numbers. 2022. Statistical compendium 2021. [Electronic resource]. Available at: https://ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/08/zb_

When justifying measures to reproduce the fertility of land resources used in crop production, it is important to divide agricultural crops depending on their influence on soil-forming processes. The group of soil-regenerating crops includes legumes, perennial and partially annual grasses, while the rest of the crops make up the group of soil-depleting crops, which dominate in terms of area. The growth of the first group crops cultivated areas will contribute to the reproduction of the soil cover fertility. The organization of agricultural land use must take into account the territorial features of the entire set of natural factors not only at the level of regions, but also the specifics of each agricultural land plot used in agricultural production (Fig. **1**).

But with such optimistic economic indicators, the problem of preserving soil fertility and rational use of soil cover in Ukraine remains extremely relevant. The transformation of soils, i.e., the increase or deterioration of their fertility, depends most on human economic activity. The assessment of the environmental stability of the territory within the regions of Ukraine by calculating the ratio of environmental stability (R en.st.) is presented in Table **4**. The score of anthropogenic loads (S a. l.) characterizes the degree of human impact on the environment, including land resources.

According to the methodology developed by the Institute of Land Management of UAAS, if the ratio of ecological stability is less than 0.33, the territory is ecologically unstable; the ratio from 0.34 to 0.50 refers to the stable unsteady; from 0.51 to 0.66, it transforms to the limit of average stability; if it exceeds 0.67, the territory is ecologically stable. Within the regions of the country, the ratio of ecological stability ranges from 0.71 to 0.27. The score of anthropogenic loads: 5 points – a high degree of anthropogenic loads (industrial land, transport, and settlements); 4 points – significant (arable land, perennials); 3 points – average (natural forage lands, meadow hollows); 2 points – insignificant (forest belts, shrubs, forests, swamps, and underwater); 1 point – low (micro-reserves). In general, in Ukraine, the anthropogenic loads are 3 and 4 points and are characterized by an average and significant degree of load.

**Table 4. Features of the Environmental State in the Regions of Ukraine as for 2021.**

| Regions | R en.st. | Environmental stability of the territory | S a. l. | Level of anthropogenic loads |
|---|---|---|---|---|
| Vinnytsia | 0,33 | unstable | 4 | considerable |
| Volyn | 0,57 | average | 3 | average |
| Dnipropetrovsk | 0,28 | unstable | 4 | considerable |
| Donetsk | 0,29 | unstable | 4 | considerable |
| Zhytomyr | 0,55 | average | 3 | average |
| Zakarpattia | 0,71 | stable | 3 | average |
| Zaporizhzia | 0,27 | unstable | 4 | considerable |

| | | | | |
|---|---|---|---|---|
| Ivano-Frankivsk | 0,62 | average | 3 | average |
| Kyiv | 0,43 | average | 3 | average |
| Kirovohrad | 0,27 | unstable | 4 | considerable |
| Luhansk | 0,41 | unsteady | 3 | average |
| Lviv | 0,53 | average | 3 | average |
| Mylolaiv | 0,28 | unstable | 4 | considerable |
| Odesa | 0,31 | unstable | 4 | considerable |
| Poltava | 0,33 | unstable | 4 | considerable |
| Rivne | 0,60 | stable | 3 | average |
| Sumy | 0,42 | unsteady | 3 | average |
| Ternopil | 0,34 | unsteady | 4 | considerable |
| Kharkiv | 0,34 | unsteady | 4 | considerable |
| Kherson | 0,34 | unsteady | 3 | average |
| Khmelnytskyy | 0,35 | unsteady | 4 | considerable |
| Cherkasy | 0,36 | unsteady | 3 | average |
| Chernivtsi | 0,51 | average | 3 | average |
| Chernihiv | 0,47 | unsteady | 3 | average |

*Source:* according to National report on the state of the environment in Ukraine in 2019 [Electronic resource]. Available at: https://mepr.gov.ua/news/37844.html

The area of arable land under cultivation in Ukraine is 32.7 million hectares, which is about 79% of the specific weight of all agricultural land in Ukraine. Regarding the rate of plowed land, Ukraine ranks first among European countries, since the rate of plowed land in Ukraine significantly exceeds the European average and is 54% in relative terms. As for the rate of land per person, this indicator in Ukraine is naturally very high and more than double the indicator in Europe. So, the facts listed above convincingly testify to the intensive agricultural land use in Ukraine (table **5**).

The soils of Ukraine are well studied, but this did not hinder the intensive processes of their degradation. The main reasons for all the problems with the soil cover are the underestimation of the real threat posed by soil degradation for the current and notably the next generations, the lack of effective mechanisms for enforcing soil protection laws, and unbalanced and scientifically unjustified land use. One of the reasons for the aggravation of the problem in Ukraine is the suspension (actually, since 1991) of state and regional land protection programs.

An alarming consequence of the high degree of plowing of soils in the country is their degradation, water, and wind erosion, and reduced productivity of land resources. In Ukraine, there are more than 1.1 million hectares of degraded, unproductive, and man-made contaminated land subject to conservation, 143.4 thousand hectares of disturbed lands in need of reclamation, and 315.6 thousand hectares of marginal lands in need of improvement. The removal of inarable, degraded, and unproductive agricultural lands and their transformation into hayfields and pastures, or afforestation is one of the key areas for improving the condition of lands and soils and combating their degradation. Areas of degraded soils in Ukraine by types of degradation are determined.

The area of agricultural lands of the country, which is affected by water erosion, is more than 13.3 million hectares (32%), including 10.6 million hectares of arable land; wind erosion – 6 million hectares, including the years of catastrophic dust storms – 20 million hectares. Up to 500 million tons of soil are lost annually in Ukraine due to erosion. Up to 24 million tons of humus, 0.96 million tons of nitrogen, 0.68 million tons of phosphorus, and 9.40 million tons of potassium (according to expert estimates) are lost with erosion products, which is much more than introduced with fertilizers. The annual growth of eroded lands reaches 80 – 90 thousand hectares.

This situation is due to non-observance of the scientifically based ratio of nutrients, the use of nitrogen fertilizers in the total amount of mineral fertilizers applied to agricultural crops, their share reaches almost 70%. The formation of crop yields in this way undoubtedly leads to a loss of soil fertility. After all, organic fertilizers remain the most important resource for ensuring reproduction of soil humus. Applying mineral fertilizers in the necessary doses for plant nutrition, while observing the optimal ratio between nutrients, is an objective necessity to ensure a deficit-free balance of nutrients and preserve soil fertility. The dynamics of fertilizer application in agricultural enterprises of Ukraine is shown in table **6**.

**Table 5. Comparative Characteristics of Land Use in Europe and Ukraine.**

| **Total Land Area** | | **Total agricultural Land Area** | | **Total Arable Land Area** | |
|---|---|---|---|---|---|
| **Total in Ukraine, million hectares** | **Specific weight to the territory of Europe, %** | **Total in Ukraine, million hectares** | **Specific weight to the territory of Europe, %** | **Total in Ukraine, million hectares** | **Specific weight to the territory of Europe, %** |
| 60,3 | 6 | 41,4 | 19 | 32.7 | 27 |
| Plowed land rate, % | | | Land per person, hectares | | |
| in Ukraine | | in Europe | in Ukraine | in Europe | |
| 54 | | 35 | 0.90 | 0.44 | |

Source: according to AgroPolit. 2020. Zemelnyi dovidnyk Ukrainy 2020 – baza danykh pro zemelnyi fond krainy. [Electronic resource]. Available at: https://agropolit.com/spetsproekty/705

**Table 6. Application of Fertilizers Per 1 ha of Sown Area in Agricultural Enterprises of Ukraine.**

| Indicator | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2017 | 2018 | 2019 | 2020 |
| **Application of Mineral Fertilizers** | | | | | | |
| per 1 ha of sown area in nutrients, kg | 58 | 79 | 110 | 121 | 119 | 141 |
| the share of fertilized area, % | 70 | 81 | 89 | 91 | 91 | 93 |
| **Application of Organic Fertilizers** | | | | | | |
| per 1 ha of sown area, t | 0,5 | 0,5 | 0,5 | 0,6 | 0,6 | 0,6 |
| the share of fertilized area, % | 2,2 | 2,5 | 2,7 | 4,4 | 4,3 | 5,4 |

Source: according to Statistical collection "Environment of Ukraine" [Electronic resource].
Available at: http://www.ukrstat.gov.ua/druk/publicat/Arhiv_u/07/Arch_dov_zb.htm

To understand the situation, it is necessary to compare the application of fertilizers, for example, in 2000 - it was 8.6 t/ha, in 2020 - 0.6 t/ha. The area fertilized with organic fertilizers is 441.8 thousand hectares or 2.5%. Such an amount of applied fertilizers cannot ensure a deficit-free balance of humus and nutrients in the soils of Ukraine, that is, the basic law of agriculture is not observed - the removal of nutrients must be compensated by returning them to the soil. As a result, a negative balance of humus and nutrients in the soil has been observed in recent years.

According to the latest agrochemical survey of soils (2011-2015), there are almost no soils with a high humus content in Ukraine. Thus, if in 1990, there were 36.9% of such soils, today, there are only 3%. The results of the analysis of data on the content of humus in the soils of Ukraine for 2015-2018 and 2019 show that over the past quarter of a century, there is a gradual decrease in the content of humus in the country as a whole, as well as in different natural and climatic zones. Thus, in 2015, the balance of humus was minus 0.3 t / ha, in 2016, minus 0.16 t / ha, in 2017, minus 0.24 t / ha, in 2018, minus 0.2 t / ha, and in 2019, minus 0.14. The best humus balance indicators were obtained in 2016 and 2019, which was due to the inflow of more organic matter into the soil. According to the recommendations of the Institute of Agriculture of the Ukrainian Academy of Sciences, for a humus balance without a deficit, the application of organic fertilizers should be increased to 14 t/ha annually in the Polissia zone, 11 t/ha in the Forest Steppe, and 9 t/ha in the Steppe. The volume of agrochemical works decreased by 2.5–5 times reclamation and other works that preserve and increase soil fertility decreased by 5-7 times. Therefore, new approaches and technological solutions to the problems of chemical soil reclamation are needed today. Even with the application of modern resource-saving technologies of chemical soil reclamation, agricultural enterprises cannot perform without state support.

One of the priority measures in the field of land protection is the conservation of degraded and marginal lands. The use of such lands is environmentally dangerous and economically inefficient. Also, using man-made contaminated land makes it impossible to obtain environmentally friendly products, as well as they are hazardous for the health of people living on these lands. According to the State Geocadastre as of 01.01.2020, in Ukraine, the total area of land in need of conservation is 865.4 thousand hectares, including the area of degraded land – 368.3 thousand hectares, the area of marginal land – 463.1 thousand hectares, and the area of man-made contaminated land plots – 34.0 thousand hectares; 143.8 thousand hectares of disturbed lands need to be rehabilitated, of which 1.2 thousand hectares were disturbed in 2019; 294.5 thousand hectares of marginal lands need improvement; it is necessary to build (reconstruct) approximately 460 anti-erosion hydraulic structures, in particular, 125 spillways, 137 anti-erosion ponds, and 198 structures of terracing slopes; it is necessary to protect lands, especially for agricultural purposes, from erosion and other adverse natural processes on a total area of 8.5 thousand hectares. In 2020, no land conservation measures were taken. From a scientific perspective, we should not only immediately stop creating new fields, but also return part of the arable land to the state of meadows, forests, steppes, and other natural systems. This objective also includes the restoration of wetlands and peatlands.

To improve the state of agrarian ecosystems and introduce an appropriate level of environmental safety and living conditions for Ukrainian citizens, it is essential to take measures to reduce arable land to 37-41% of the country's territory by removing certain categories of lands, while increasing the share of extensive agricultural land (hayfields, pastures) following scientifically sound indicators. The reduction of arable land is taking place in the EU and other countries. Such measures are implemented within the framework of state programs directed at environmental protection and ensuring the proper environmental standard of human life.

Increasing the efficiency of land use in agricultural enterprises is a rather difficult task, since a whole system of interrelated factors, which have different degrees of influence and different nature of actions, is functioning. Thus, it is widely known that increasing the yield of agricultural crops is significantly influenced by the fertility of the land, as well as the intensity level of material and monetary investments in production. If the influence of the first factor is determined by zonal natural and climatic features to a certain extent, then the level of the material and monetary costs contribution is related to the culture of farming, the availability and quality of agricultural machinery, the organization of work, etc.,

**Table 7. Statistical and Mathematical Model of Agricultural Enterprises Profitability.**

| Groups and Subgroups of Factors | | | Average Indicators of Profit per 1 ha with Different Factor Combinations, UAH | | Number of Enterprises |
|---|---|---|---|---|---|
| La = 2 | Lb = 2 | Lc = 2 | V | $M_x = \frac{\sum V}{n_i}$ | $n_i$ |
| $A_1$ | $B_1$ | $C_1$ | 70; 81;… | 70 | 7 |
| | | $C_2$ | 286; 389; … | 197,68 | 6 |
| | $B_2$ | $C_1$ | 410; 90; … | 230 | 7 |
| | | $C_2$ | 100; 90; … | 137,15 | 7 |
| $A_2$ | $B_1$ | $C_1$ | 220; 250; .. | 240 | 7 |
| | | $C_2$ | 380; 180; .. | 448,15 | 7 |
| | $B_2$ | $C_1$ | 580; 550; .. | 771,42 | 7 |
| | | $C_2$ | 880; 590; … | 788,56 | 7 |
| Total | | | | X | 55 |

meaning the connection with the economic activity of a person. Since the efficiency of land use is influenced by various factors of production, it is important to know the degree of these factors influence in order to determine further directions of effective land use. For this purpose, a statistical and economic analysis of natural and economic factors influence on the efficiency of land use in agricultural enterprises was carried out. We have conducted a study of changes in the land productive potential in two administrative and economic districts of the Kharkiv region depending on the factors of production intensification by means of dispersion and correlation-regression modeling of the agricultural land unit profitability (Table **7**).

We calculate the variance according to the following formula:

$$Cy = \sum V^2 - \frac{\left(\sum V\right)^2}{n} = 6204593.84$$

$$C_x = \sum h - \frac{\left(\sum V\right)^2}{n} = 3836792.8$$

$$C_z = \sum V^2 - \sum h = 2367801$$

The influence degree of the studied factors is:

$\eta 2_x$=0.618(61.8%); $\eta 2_z$=0.382(32.8%)

The empirical value of reliability criterion (Fp) is: $F_A$ = 44.85; $F_B$ =16.31; $F_C$ =1.16; $F_{AB}$ =10.31; $F_{AC}$ = 0.62; $F_{BC}$ = 2.90; $F_{ABC}$ = 76.15.

The obtained statistical-mathematical parameters of the dispersion model lead to the following conclusions: the influence degree of the land quality factors, funding and their interaction is 61.8 percent, the amount of unaccounted factors is 38.2 percent; the influence degree of factor A, that is, the quality of the land, on the formation of the profit indicator is 35.3 percent; the fund provision of enterprises (factor B) determines the variation of the obtained profit indicator by 12.1 percent; factor C, i.e. the capital adequacy of enterprises, determines the influence of 9.0 percent.

## 4. CONCLUSION

The interests, connections and dependencies that arise according to the restoration of land resources useful properties lost during economic activity have a sufficient ecological and economic orientation. Two directions of public interests and dependencies manifestation are quite clearly distinguished: the first is about interests and dependencies in connection with the restoration of land resources useful properties as a natural component, the second is about economic indicators of the economic activity of land users. In the first case, there is a coping activity.

In the second case, under modern conditions, the following is observed in most enterprises: a discrepancy between indicators of the fixed assets availability and their real usefulness; inefficient use of labor and material resources; uneven need of enterprises for funds, etc. The presence of such irrationality leads to inefficient use of land, and, as a result, low efficiency of production, that is, its profitability.

The methodological basis of the state land policy formation regarding land use management is the goals of sustainable (balanced) development, on the basis of which the priorities of social, economic and ecological development are formed in both global and local dimensions. In particular, the formation of sustainable (balanced) development of land use involves the conscious formation of balanced relations between economic growth (economic component), care for the environment (ecological component) and human health (social component).

The land use system is an open socio-ecological-economic system with certain boundaries, within which its subsystems, characterized by specific features and system organization, interact, and the socio-ecological-economic system is a ho-

listic (integrative) entity that combines economic, social, institutional and ecological subsystems. Thus, the program of land use sustainable development can be implemented at different hierarchical levels, which is reflected in the global environmental policy, in the state environmental and land policy, in the regional and local land and environmental policy (level of territorial communities). The state administration itself is called to ensure the proper institutional conditions for the sustainable (balanced) development of land use as an ecological and economic system. Effective management directly depends on a reasonable balance of economic, environmental and social levers.

An important component of the sustainable land use formation is the determination of its indicators. Indicators of sustainable land use development are indicators derived from the primary data of the State Land Cadastre, social and economic statistics, which are used to interpret the current situation and monitor the dynamics of changes. They, on the one hand, should provide a quantitative description of the achievement of sustainable land use development goals, on the other hand, should be used for a generalized definition and clarification of sustainability key aspects.

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