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RESTRUCTURING AGRICULTURAL LAND USE IN UKRAINE: DIRECTIONS FOR DEVELOPMENT

Anton Tretiak[1]✉, Liudmyla Hunko[2]✉

[1] ORCID: 0000-0002-1154-4797
[2] ORCID: 0000-0002-9454-744X
[1] Bila Tserkva National Agrarian University
Cathedral Square, 8/1, Bila Tserkva, Kyiv region, 09117, **Ukraine**
[2] National University of Life and Environmental Sciences of Ukraine
Vasylkivska Street, 17, Kyiv, 03040, **Ukraine**

ABSTRACT

The intensity of agricultural land use in Ukraine was analyzed based on soil quality and the values of the land-use intensity (LUI) index and the land-use capacity (LUC) index. In the administrative districts of Cherkasy region, the LUI index ranged from 0.07 to 1.0, and the LUC index ranged from 0.01 ha per 1000 UAH of gross output to 0.19 ha per 1000 UAH, which points to considerable difference in land-use intensity and agricultural land-use capacity. New approaches should be sought to improve the management and use of agricultural land. Functional land use areas should be restructured, in particular, by implementing non-traditional methods of agricultural land use. The results of the study indicate that land-use functions should be modified over an area of 5,343,900 ha, where 2,049,900 ha should be converted to crop rotations for soil protection, 208,000 ha – to protective forest margins; and 2,878,000 ha – to non-traditional forms of agricultural land use.

Motives: The purpose of the article was to propose a methodological approach for assessing the intensity of agricultural land use and to suggest directions for land-use restructuring to improve its ecological status.

Aim: In the proposed methodical approach, the intensity of agricultural land use was assessed with the land-use intensity (LUI) index and the land-use capacity (LUC) index. To reduce plowing and increase land-use intensity, the functions of degraded arable land should be modified over an area of 5,343,900 ha, where 2,049,900 ha should be converted to crop rotations for soil protection, 208,000 ha – to protective forest margins; and 2,878,000 ha – to non-traditional forms of agricultural land use.

Results: The article substantiates the need to modify the functions of arable land over an area of 5,343,900 ha, where 2,049,900 ha should be converted to crop rotations for soil protection, 208,000 ha – to protective forest margins; and 2,878,000 ha – to non-traditional forms of agricultural land use.

Keywords: economics, agricultural land use, land-use planning, soil suitability, functional use

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

INTRODUCTION

The Ukrainian land fund is characterized by an extremely high level of development. About 70% of the land fund in Ukraine is agricultural land.

The high level of economic development in the territory of Ukraine determines the intensive impact of anthropogenesis on the surrounding natural environment, including land resources and the structure and character of processes that occur in the field of land use.

The concept of the National Target Program for Land Use and Protection (Concept, 2022) suggests reducing agricultural exploration in Ukraine by 5% and the plowing of the territory by 10%. The plowing of the Ukrainian territory reaches 54%, and the plowing of the Cherkasy region, which was chosen as the base for the investigation, reaches 61% (Tretiak et al., 2022).

Taking into account that arable land is mainly privately owned, restructuring of agricultural land use requires the development of new approaches and methods of organizing land use, economic and land management mechanisms, and tools for agricultural land use ecologization. These approaches and methods of organizing agricultural land use include:

1. Multifunctional approach to land use planning (Tretiak et al., 2021): prioritizing and balancing the stakeholders' needs on a regional, district and territorial communities' scale, taking into account local land use specifics, demand for land and other natural resources, and their quality – to ensure a full range of land benefits and services. Territorial and spatial land use planning helps to determine the types of land use that will maximize the fulfillment of people's needs and preserve soil, water and biodiversity for future generations;
2. Building resilience to external influences: increasing the adaptive capacity of ecosystems through a combination of environmental protection measures, sustainable land use management, and restoration of land and other natural resources (Tretiak et al., 2021). There are many tools and practices to protect the functionality, productivity, and diversity of land and other natural resources that can help minimize the effects of climate change and other impacts, as well as adapt to these effects (Tsyuk et al., 2021);
3. Agricultural activities aimed at optimizing the best possible set of ecosystem services related to food production. It requires a fundamental change of agricultural practices to achieve a wider range of social, environmental, and economic benefits through the land capital management that develops in the process of land use (Tretiak & Lyashynskyy, 2019).

In particular, in order to reduce the plowing of the territory of Ukraine, in addition to the main ways of further possible land use, which are to change according to functional use, it is suggested to include (Tretiak et al., 2022):

1. Arable land with degraded and unproductive soil for use in soil protection and restoration crop rotations;
2. Increasing the area of shelterbelts to reduce the impact of climate change and its erosive effects;
3. Enlargement of area for unconventional agricultural land use.

Such restructuring of agricultural land use is possible only within the territorial and spatial planning of land use development. This planning is a key tool for the formation of multifunctional territories. According to the research of a group of Ukrainian scientists, "territorial and spatial planning performs the functions of regulating land and environmental relations and land use development" (Tretiak et al., 2021). As a regulatory mechanism (at the local, regional, and/or national levels), it should determine the permission for specific agricultural activities; as a development mechanism, it should design tools for land use development to provide services and create infrastructure, preserve land and other natural resources, establish investment incentives, and increase capitalization and ecologization of land use.

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

LITERATURE REVIEW

Problems of restructuring and ecological and economic organization of the system of agricultural land use are considered by Ukrainian and foreign scientists. Horlachuk (1999) deals with the problems of land market formation and real estate registration, organization of farm land use, and preservation of soil energy potential. The study by Martyn et al. (2022) identifies ways to improve the mechanism of legal regulation of land consolidation in Ukraine and integrated land management, which will ensure restructuring and improvement of spatial conditions for agriculture, the achievement of more efficient multifunctional use of rural areas, environmental protection, and infrastructure development for further harmonization of legislation. Martyn et al. (2022), Kuryltsiv (2007), note that large-scale destruction of land resources, especially due to soil erosion, and the constantly growing population in the world exacerbate the issue of food supply and lead to the search for new approaches to land use optimization. Stupen and Greschuk (2017) points out that in order to reconcile the environmental and food interests in agricultural land use, it is necessary to change the mechanism of land relations management, the component of which should be the land management of especially valuable lands in agriculture. Tretiak (2021) substantiate the main principles of the concept of modern land management and land use, the introduction of functional land use areas, and the formation of land use resilience to external influences. Khvesyk (2014) proves that economic activity requires the updating of organizational forms and determines the place and role of the financial and economic components in the process of capitalizing on natural resources from the perspective of their profitability. It is also necessary to consider the work of researchers Anh, Bong and Tam (2019), who argue that sustainable land use management deals with current and future areas of the economy, society, culture, and environment and limits the degradation of land and water resources, as well as reduces production costs. Dudzinska (2019), in her research, considers the socio-spatial area of farms as a criterion for choosing a place for the consolidation of agricultural land. Janus and Taszakowski (2018) deal with a regional approach to prioritizing land consolidation that will increase the productivity of agricultural areas. Mika, Len, Oleniacz and Kurowska (2019) suggest an algorithm that enables a detailed assessment of the structure of farms and determines the distribution of land owned by farmers.

Despite the sufficiently thorough level of development of the investigated issues, methodological and methodical problems related, in particular, to the development of new approaches and methods of land use organization, economic and land management mechanisms and tools for the greening of agricultural land use, etc., remain unresolved. The lack of a systematic approach to solving the defined range of problems determines the relevance of the research, its purpose, object and subject.

MATERIALS AND METHODS

The theoretical and methodological basis of the study is the provisions and principles of agricultural land use restructuring and the results of research by domestic and foreign scientists, which reveal the main directions of land use organization, economic and land management mechanisms, and tools for the greening of agricultural land use. Table 1 shows the assessment of the existing level of intensity of agricultural land use in the administrative district of the Cherkasy region and illustrates the level of efficiency of the use of existing agricultural land, taking into account its quality. To assess the level of intensity of land use, the author uses the indicator of land use capacity, which is characterized by the ratio of specific indicators of land area and gross output in monetary terms. The normative indicator of land use capacity is 0.01 and characterizes the highest intensity of land use.

During the research, general scientific and special research methods were used, namely: dialectical – to identify the conditions of agricultural land use, their effectiveness and efficiency; analysis – to highlight the necessity of restructuring agricultural

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

Table 1. The assessment of the existing level of intensity of agricultural land use in the administrative district of the Cherkasy region

Districts of the Cherkasy region	Soil quality index*	GP**, UAH ths, const. prices of 2016	Arable land area***, ha	GP per 1 ha, UAH ths.	GP conv, UAH ths./ conv. cadastral ha	Land use intensity index
Cherkasy	41	504810	47904	10.5	13.4	0.12
Chornobai	54	1091041	44849	24.3	23.4	0.21
Chyhyryn	39	374537	93509	4.0	5.3	0.05
Drabiv	60	863063	94198	9.2	7.9	0.07
Horodyshche	46	521094	51952	10.0	11.3	0.10
Kamianka	52	407105	45519	8.9	8.9	0.08
Kaniv	**40**	**4136187**	**47865**	**86.4**	**112.3**	**1.0**
Katerynopil	57	521094	50033	10.4	9.5	0.9
Khrystynivka	58	488526	50090	9.8	8.7	0.08
Korsun-Shevchenkivskyi	43	488526	46655	10.5	12.7	0.11
Lysyanka	51	488526	51414	9.5	9.7	0.09
Mankivka	58	569947	57599	9.9	8.9	0.08
Monastyryshche	59	472242	53203	8.9	7.8	0.07
Shpola	52	716505	81119	8.8	8.8	0.08
Smila	49	569947	52381	10.9	11.5	0.10
Talne	57	635084	70336	9.0	8.2	0.08
Uman	57	911915	106140	8.6	7.8	0.07
Zhashkiv	65	749073	76642	9.8	7.8	0.07
Zolotonosha	54	993336	83285	11.9	11.5	0.10
Zvenyhorodka	46	537379	62698	8.6	9.7	0.09
The entire Cherkasy region	**52**	**16039937**	**1267391**	**12.6**	**12.6**	**0.11**

* *Source*: the calculation is based on the Ukrainian soil assessment data.
** Agriculture in the Cherkasy region in 2019. Department of Statistics in the Cherkasy region. In the comparative prices of 2016, agricultural products are represented.
*** According to the State land cadastre of the Cherkasy region as of January 1st, 2020.

land use; synthesis – to combine different doctrines regarding the use of arable land; structural and functional analysis – to determine the main stages and components of the organization of agricultural land.

RESULTS

Today, land resources are an extremely important structural element of civilization. Global changes in the redistribution and use of land, especially in agriculture, have a number of negative consequences that lead to intensified interstate to limit resources. In the context of globalization, the use of land resources is accompanied by excessive use of nature in agricultural production (Chumachenko et al., 2023).

In order to determine approaches and methods of organizing agricultural land, it is suggested that the level of efficiency of the existing agricultural land use should be assessed, taking into account its quality. This will enable the most accurate estimation of the results of land use. Table 1 presents an assessment of the existing level of intensity of agricultural land use in the administrative districts of the Cherkasy region as of 2019 (2019 indicators most accurately reflect trends in land use) (Agriculture of Cherkasy region, 2020) (Fig. 1).

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

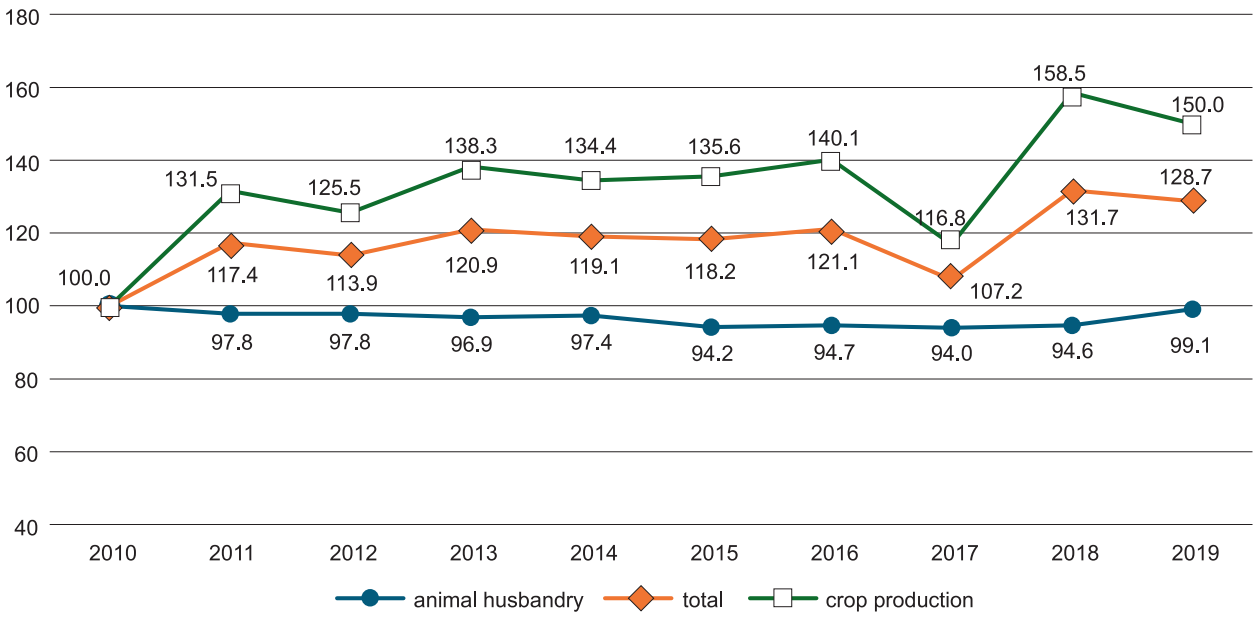

Fig. 1. Trends in agricultural production in the Cherkasy region. The year 2010 is taken as 100% (Agriculture of the Cherkasy region in 2019)

The existing agricultural land use intensity index (LUI) is calculated with the formula:

$$LUI = GP_{conv.exist.} / GP_{conv.norm.}, \quad (1)$$

where:

$GP_{conv.exist.}$ – the value of gross agricultural production per conventionally cadastral hectare of arable land in the existing region, UAH / conventionally cadastral hectare;

$GP_{conv.norm.}$ – the value of gross agricultural production per conventionally cadastral hectare of arable land, which is taken as a standard (the highest among the districts), UAH / conventionally cadastral hectare.

The value of gross agricultural production per conventionally cadastral hectare of arable land is calculated with the formula:

$$GP_{conv.} = GP \times AVG_{region} / AVG_{district}, \quad (2)$$

where:

AVG_{region} – the average-weighted soil quality index in a region;

$AVG_{district}$ – the average-weighted soil quality index in a district.

As shown in Table 1, the existing agricultural land use intensity level – taking into account soil quality index and soil natural fertility in the administrative districts of the Cherkasy region – is very low in comparison to Kaniv district, which is taken as the normative one. The high intensity level of agricultural land use in Kaniv district is confirmed by statistics on the gross agricultural production in 2019 (Fig. 2).

The reason for the striking difference in land use intensity level is the implementation in Kaniv district of a soil-protective and resource-saving agriculture system, which is a component of unconventional agricultural land use. Land use capacity (LUC) is another indicator to confirm the findings about the level of land use intensity. Land use capacity indicates land resource consumption (LR) for the production

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

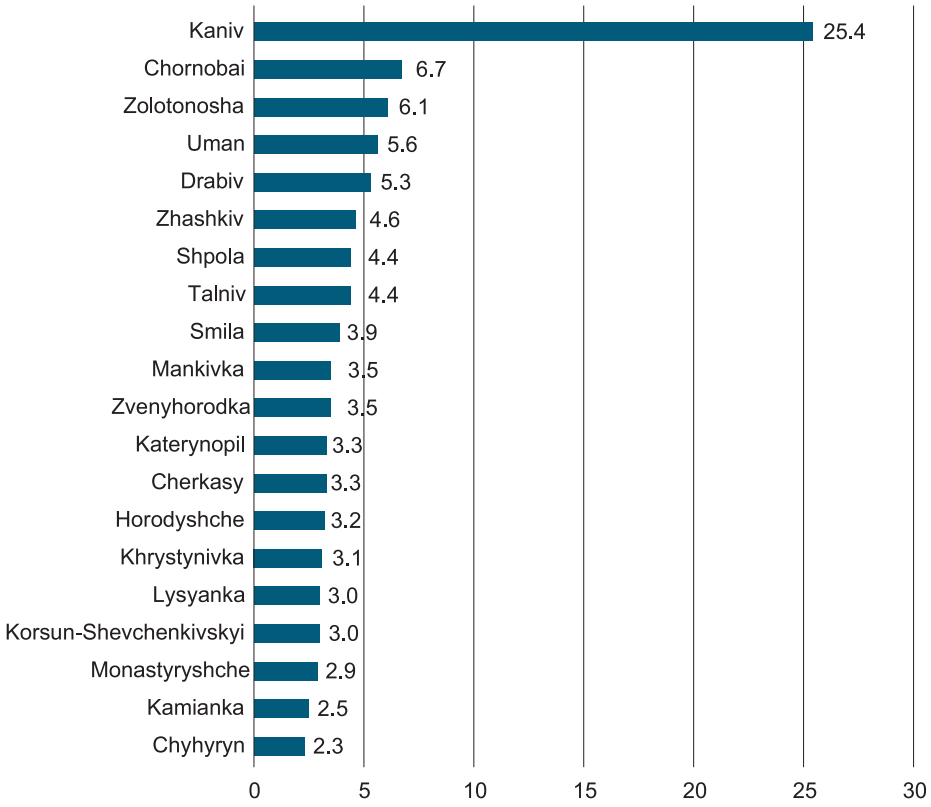

Fig. 2. Ranking of districts of the Cherkasy region by gross agricultural production in 2019 (share in the total amount); Agriculture of the Cherkasy region (2019)

of a specific type of product or all the products in terms of value (GP) and is calculated by the formula:

$$LUC = LR / GP \quad (3)$$

Land use capacity is expressed in terms of the value of land required to produce a unit of output in monetary terms. Table 2 presents an assessment of the existing agricultural land use capacity in the administrative districts of the Cherkasy region.

As shown in Table 2, the existing agricultural land use capacity in the administrative districts of the Cherkasy region is quite high (mostly 10 times higher) compared to the land use capacity in the Kaniv district (0.01 ha per 1000 UAH of GP). Consequently, since the land use capacity ranges from 0.01 to 0.25 hectares per 1000 UAH of GP, agricultural land use in Kaniv district can be described as rational. Its value differs by 25 times. Agricultural land use capacity is calculated taking into account the soil quality index, which ranges from 0.01 to 0.19 hectares per 1000 UAH of GP or – to be more objective – varies by 19 times.

The degree of agricultural land use capacity is influenced by the share of organic agricultural production, which is also a component of unconventional land use. Figure 3 shows the area of land that is suitable for organic farming in Ukraine.

The differentiation of terrestrial ecosystems of Ukraine in terms of ecological and genetic suitability for organic production was carried out as a part of the research program "Agroecological basis for the recreation of soil fertility for organic farming on agricultural landscapes of Ukraine". The soils of Vinnytsia, Ternopil, Khmelnytsky, Chernivtsi, Poltava, Kharkiv, and the Cherkasy are the most suitable for organic farming in Ukraine. But despite the prospects of this approach, the share of agricultural land in the Cherkasy region, where organic technologies are used, is still insignificant

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

Table 2. The assessment of the existing agricultural land use capacity in the administrative districts of the Cherkasy region

Districts of the Cherkasy region	GP*, UAH ths., const. prices of 2016	Arable land area**, ha	GP per 1 ha, UAH ths.	LUC, ha per 1000 UAH of GP	GP_{conv}, UAH ths./ conv. cadastral ha	LUC, conv. cadastr. ha per 1000 UAH of GP
Cherkasy	504810	47904	10,5	0,10	13,4	0,07
Chornobai	1091041	44849	24,3	0,04	23,4	0,04
Chyhyryn	374537	93509	4,0	0,25	5,3	0,19
Drabiv	863063	94198	9,2	0,11	7,9	0,13
Horodyshche	521094	51952	10,0	0,10	11,3	0,09
Kamianka	407105	45519	8,9	0,11	8,9	0,11
Kaniv	**4136187**	**47865**	**86,4**	**0,01**	**112,3**	**0,01**
Katerynopil	521094	50033	10,4	0,10	9,5	0,10
Khrystynivka	488526	50090	9,8	0,10	8,7	0,11
Korsun-Shevchenkivskyi	488526	46655	10,5	0,10	12,7	0,08
Lysyanka	488526	51414	9,5	0,11	9,7	0,10
Mankivka	569947	57599	9,9	0,10	8,9	0,11
Monastyryshche	472242	53203	8,9	0,11	7,8	0,12
Shpola	716505	81119	8,8	0,11	8,8	0,12
Smila	569947	52381	10,9	0,09	11,5	0,09
Talne	635084	70336	9,0	0,11	8,2	0,12
Uman	911915	106140	8,6	0,12	7,8	0,13
Zhashkiv	749073	76642	9,8	0,10	7,8	0,13
Zolotonosha	993336	83285	11,9	0,08	11,5	0,09
Zvenyhorodka	537379	62698	8,6	0,12	9,7	0,10
The entire Cherkasy region	**16039937**	**1267391**	**12,6**	**0,08**	**12,6**	**0,08**

* Agriculture in the Cherkasy region in 2019. Department of Statistics in the Cherkasy region. In the comparative prices of 2016, agricultural products are represented.

** According to the State land cadastre of the Cherkasy region as of January 1st, 2020.

and amounts to only 1.6 thousand hectares (about 0.2% of the total agricultural land area).

Considering the effectiveness of unconventional agricultural land use (Tretiak et al., 2022), we suggest the restructuring of the areas of arable land use in regions of Ukraine (Table 3).

Consequently, our research suggests that 5343.9 thousand hectares of arable land are to be changed for functional use: 2049.9 thousand hectares – for soil protection and soil restoration crop rotations; 208.0 thousand hectares – to expand the area under shelterbelts; and 2878.0 thousand hectares – for unconventional agricultural land use. In the Cherkasy region, the area of arable land that needs to be converted to unconventional agricultural land use is 65.7 thousand hectares, or 5.2% of the total arable land.

Production activities in the Cherkasy region are provided by 573 agricultural enterprises, 1401 farms, 94 agricultural cooperatives, and 201 thousand private peasant farms (The state of development, 2023). The development of unconventional agricultural land use will be mainly driven by an increase in the number of family and peasant farms.

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

Fig. 3. Map of soils that are suitable for organic farming in Ukraine (The map of lands, 2019)

Table 3. Author's suggestions for restructuring the directions of arable land use in Ukrainian regions to reduce plowing

Region, region	Parameters					
	Existing arable land area, ths. ha	Arable land according to plowing rates, ths. ha	Arable land to be changed by functional use, ths. ha	This includes the following directions		
				soil protection and soil restoration crop rotations, ths. ha	under shelterbelts, ths. ha	unconventional agricultural land use, ths. ha
1	2	3	4	5	6	7
Cherkasy	**1271.9**	**1045.8**	**226.1**	**146.4**	**7.0**	**65.7**
Chernihiv	1477.8	1467.5	10.3	10.3	-	-
Chernivtsi	327.6	297.1	30.5	30.5	-	-
Dnipropetrovsk	2152.6	1596.2	556.4	97.5	21.5	415.9
Donetsk	1654.2	1325.9	328.3	142.2	16.0	154.1
Ivano-Frankivsk	400.6	377.4	23.2	23.2	-	-
Kharkiv	1932.5	1570.9	361.6	90.4	13.0	245.2
Kherson	1784.6	1423.1	361.5	168.0	15.0	163.5
Khmelnytsky	1326.3	1031.5	294.8	141.2	-	153.6
Kirovohrad	1769.0	1229.4	539.6	84.3	27.9	399.5
Kyiv	1320.4	1318.9	1.5	-	1.5	-
Luhansk	1275.9	1267.4	8.5	8.5	8.5	-
Lviv	772.6	768.5	4.1	4.1	-	-

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

cont. Table 3

1	2	3	4	5	6	7
Mykolaiv	1703.7	1229.3	474.4	80.4	17.0	360
Odesa	2077.0	1665.7	411.3	215.7	25.0	145.6
Poltava	1816.8	1437.5	379.3	164.5	10.0	194.8
Rivne	658.6	641.6	17	17	-	-
Sumy	1234.7	1167.8	66.9	52.6	-	14.3
The Crimea	1272.2	1272. 2	0.0	-	-	-
Ternopil	852.0	691.2	160.8	91.7	-	69.1
Vinnytsia	1730.4	1324.6	405.8	114.5	9.6	272.1
Volyn	684.6	676.8	7.8	7.8	-	-
Zakarpattia	199.9	117.3	82.6	28.3	-	54.3
Zaporizhzhia	1900.8	1359.2	541.6	296.5	26.0	193.1
Zhytomyr	1143.9	1109.6	34.3	34.3	-	-
Ukraine	**32756.0**	**27412.1**	**5343.9**	2049.9	208.0	2878.0

CONCLUSIONS

In the course of the study of the level of intensity of agricultural land use, the authors have formed the following main opinions.

The assessment of the existing level of intensity of agricultural land use should be carried out taking into account the quality of the soil and the methodical application of the indicators „land use intensity index" (LUI) and „land use capacity" (LUC). Thus, according to the data from the assessment of the current state of land use in the administrative districts of the Cherkasy region, the land use intensity index ranges from 0.07 to 1.0, which indicates a large difference in the level of intensity of land use. A comparison of the level of intensity of land use by the indicator of land use capacity also confirms a large difference in the level of intensity of land use. The land use capacity ranges from 0.01 hectares per 1000 UAH of gross output to 0.19 hectares per 1000 UAH, which indicates a large difference in the level of land use intensity and agricultural land use capacity. The current state of agricultural land use requires the development of new approaches to land use organization. It is suggested to restructure the areas of functional land use, in particular, to implement non-traditional agricultural land use. The article substantiates the necessity of changing the functional use of arable land in the area of 5343.9 thousand hectares, namely: 2049.9 thousand hectares – for use in soil-protective crop rotations; 208.0 thousand ha – for expansion of areas under field protection forest strips; and 2878.0 thousand ha – for non-traditional agricultural land use.

In order to implement measures to reduce arable land in Ukraine, as provided by the Concept of the National Targeted Program for the Use and Protection of Land, it is proposed to restructure the directions for the use of arable land in the regions of Ukraine. To determine possible approaches and methods of agricultural land organization, it is proposed to evaluate the level of efficiency of existing agricultural land use, taking into account their quality, and an assessment of the existing land capacity of agricultural land use is given. A restructuring of the directions of arable land use is proposed, as a result of which arable land with an area of 5343.9 thousand hectares will be subject to a change in functional use and will lead to a decrease in the economic development of the territory of Ukraine.

Author contributions: author approved the final version of the article. The following authors contributed to this work: T.A. and H.L. developed the concept, H.L. designed the research, H.L. collected data, T.A. and H.L. analyzed and interpreted the data, H.L. prepared the draft of the article, T.A. reviewed the article critically for important intellectual content.

✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net

Note: the results of this study were presented in another form, such as a poster/abstract at the 3rd International Conference on Water Management and its Surroundings – Theoretical and Practical Aspects.

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✉tretyak2@ukr.net, ✉liudmyla_g@ukr.net