

## ECOLOGICAL AND ECONOMIC ASSESSMENT OF THE POTENTIAL OF AGRICULTURAL LAND

Orest FURDYCHKO<sup>1</sup>, Roman HULINCHUK<sup>1</sup>, Iryna SAMOILOVA<sup>2</sup>

<sup>1</sup>Institute of Agroecology and Nature Management of National Academy of Agrarian Sciences of Ukraine, 12 Metrological St., 03143, Kyiv, Ukraine, Phone: +380445269221, Mobile: +380972220341, E-mails: agroecologynaan@gmail.com, rgulinchuk@hotmail.com

<sup>2</sup>University of the State Fiscal Service of Ukraine, 31 Universytetska St., 08201, Irpin, Kiev Region, Ukraine, Phone: +380459756595, Mobile: +380982824995, E-mails: samoilova\_irina@ukr.net

**Corresponding author:** rgulinchuk@hotmail.com

### Abstract

*Improved methodological approach to the environmental and economic assessment of the potential of agricultural land which is based on the use of an integral index, which sufficiently characterizes the properties, functions and possibilities of using land resources in agricultural production. The integral index of the potential of agricultural land was proposed to be calculated as the average value of the normalized indicators of agroclimatic potential, soil bonitet and regulatory and monetary assessment of land. This approach allows us to determine in the future the objective level and efficiency of using the potential of agricultural land both at the level of territories and economic entities. An environmental-economic assessment of the potential of agricultural land in the Kiev region. On the basis of theoretical and methodological approaches, an assessment was made of the effectiveness of the use of the potential of agricultural land in the districts of the Kiev region. The proposed approach provided for comparing the cost estimates of the theoretical and actual productivity of land resources in agriculture, calculated on an integral score of the potential of agricultural land. The evaluation results indicate that the level of use of the potential of agricultural land varies from 31.8 to 293.8 %. It was found that eight districts of the region use the potential of agricultural land at a low level, and in most areas the actual figures exceed the theoretical one by 1-2 times.*

**Key words:** ecological and economic assessment, potential, agricultural land, integral indicator.

### INTRODUCTION

Agriculture is one of the branches of the economy of Ukraine, where involvement in the production of land resources is one of the determining factors for its development. However, now, due to the introduction of intensive production technologies in the agrarian sphere, the condition of the lands used for farming is deteriorating. The soil cover undergoes degradation, loses its resistance to destruction, its ability to restore the properties and reproduction of fertility decreases. To solve these problems, the integrated analysis of land potential and the development of ways to improve the effectiveness of its use are of great importance. The solution of this issue is particularly acute in the modern conditions of market economy. Therefore, an objective assessment of the potential of agricultural

land and the efficiency of its use should serve as a basis for substantiating the directions for improving all the main elements of the ecological and economic mechanism of land use.

Also, there is a need to revise some methodological approaches to study the process of restoring potential. As can be seen from the above, the potential of agricultural land is a complex multi-factor category, which currently does not have a single unambiguous interpretation and assessment methodology. We believe that the assessment of the potential of land resources should be considered as a whole, both the economic and the resource and production potential.

Along with this, as a result, of market transformations in the sphere of land relations, the conditions for the use of the potential of agricultural lands changed dramatically, resulting in a deterioration of their ecological

and economic characteristics. Therefore, there is a need to revise the theoretical and methodological foundations and substantiate the system of measures to preserve the productivity of land in the conditions of market relations. Issues of ecological and economic support for assessing the use of land potential in agriculture also remain insufficiently studied. In general, the lack of an integrated approach to solving these environmental and economic problems in the field of using the potential of agricultural land and determine the relevance of the topic of the research.

## MATERIALS AND METHODS

Ecological and economic assessment of the potential of agricultural land and the level of effectiveness of its use were carried out on the example of districts of the Kiev region of Ukraine.

The informational basis of the study consists of domestic and international laws and regulations in the field of land relations, land use economics, environmental protection, materials and reports of the State Statistics Service of Ukraine, State Agency of Land Resources of Ukraine, Ministry of Agrarian Policy and Food of Ukraine, Ministry of Ecology and Natural Resources of Ukraine State Enterprise "Institute of Soil Protection of Ukraine", State University "Kiev Research and Design Institute of Land Management", and also guidelines academic institutions, information from Internet resources, materials own research and other sources of literature on the problems of research.

It was proved that along with traditional indicators of agricultural land use efficiency (the ratio of production and financial activity results in terms of value or in kind to a unit of land resources used), it is advisable to use an indicator of the level of their potential realization, comprehensively reflect the achieved level and possible reserves for increasing agricultural production. Improved methodological approach to the environmental and economic assessment of the potential of agricultural land provides for the use of an integral index, which is

characterized by indicators of agroclimatic potential, bonitet and regulatory and monetary assessment of land. The integral index of the ecological and economic assessment of the potential of agricultural land ( $I_p$ ) is calculated as the average of the normalized values of the above indicators:

$$I_p = \frac{\sum_{j=1}^n \hat{x}_{ij}}{n} \times 100, \quad (1)$$

where  $x_{ij}$  – normalized value  $j$ -th indicator for  $i$ -th district;  
 $n$  – the number of indicators used in the calculation.

The normalized values are calculated by the formula:

$$\hat{x}_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}}, \quad (2)$$

where  $x_{ij}$  – the value of the  $j$ -th indicator for the  $i$ -th district;

$x_j^{\min}$  – minimum value of  $j$ -th indicator;

$x_j^{\max}$  – maximum value of  $j$ -th indicator.

It is proposed to distinguish between two levels of determining the potential of agricultural land: 1) territorial and 2) business entities. Ecological and economic assessment of the potential of agricultural land at the territorial level involves taking into account the possible volume of production per unit area, depending on the natural properties of these lands. At the level of individual agricultural land uses, the ecological-economic assessment of potential should be carried out taking into account the internal specialization of various forms of management.

## RESULTS AND DISCUSSIONS

In the economy of agriculture, the rational use of land resources is of particular importance, because obtaining high-quality products in the required quantity is due precisely to the qualitative condition of the land, the nature and conditions of its use. The land is an important productive force, without which the

process of agricultural production is impossible. This implies the importance of taking into account its productive characteristics, since any individual land plot is characterized by a combination of spatial, soil, quality and other properties, is its potential. It is revealed that in the scientific literature today the concepts of "resource", "economic", "production", "economic" potentials are identified. However, with respect to land, where the potential is a complex multifactor category, these types are interrelated, therefore, the assessment of the potential of land resources should be considered as a combination of these potentials. It was established that, on the one hand, the potential of agricultural land characterizes their properties and quality, and on the other, it is the basis for assessing the efficiency of land use based on the determination of the level of realization of this potential. Despite this, the potential of agricultural land should be considered as a set of properties and functions of land resources and the possibilities of obtaining the maximum level of efficiency from their use in agricultural activities in order to meet the needs of society and preserve the natural environment [2; 6].

This interpretation of the concept of potential of agricultural land makes it possible to consider it not only as a scientific category, but at the same time to understand its practical value for agricultural producers, as well as society as a whole.

Considering that the level of realization of current and potential opportunities directly affects the achievement of the operational, tactical and strategic goals of an agricultural enterprise, an objective need arises in determining its quality, i.e. assessment of the potential of agricultural land [1]. Moreover, the main characteristic of the potential in the process of such an assessment should be its value for achieving these goals. It is advisable to characterize the potential of an enterprise not by one indicator, but by their totality, and depending on the nature of the indicator itself, apply either a value, or a real, or any other, for example, heuristic estimate. The methodological basis for determining the

potential is the ratio of the result with the resources expended to achieve these potential values. At the same time, indicators assessing the level of utilization of the elements of the potential should enable a comparative assessment of both the effectiveness of the use of various elements of the potential of one enterprise and various production systems [7]. The concept of valuation seems to be the most universal and methodological justified, since it takes into account all the necessary requirements for the potential as an object of assessment. The initial prerequisite for valuation is that an enterprise as an object is characterized by a certain level of potential, can be a source of income and an object of a market transaction [4; 5].

Data analysis shows that Ukraine has a significant potential for land resources in agriculture: 71.03%, or 42.74 million hectares – agricultural land, in the structure of which agricultural land – 97.5%, of which 78.3% is arable land.

A positive tendency towards an increase in the efficiency of land use, characterized by an increase in the volume of gross output (over the past 15 years, gross crop production increased by 189.5%), crop yields, and their gross yield, has been revealed. However, an increase in the acreage of maize, sunflower and rape while reducing the proportion of cereals negatively affects the quality characteristics of the soil, against the background of non-compliance with scientifically based crop rotations and not using soil protection agents leads to its depletion and loss of fertility. The result of such changes is the reduction of humus in the soil for the period 1991–2017. From 3.3 to 3.1%, which eventually leads to a decrease in crop yields. And all the above-mentioned positive changes are achieved only through the use of new intensive technologies and new high-yielding varieties of crops, and by no means contribute to the preservation and reproduction of the natural (potential) fertility of lands. It is revealed that at present due to over-plowing the deficient balance of nutrients, insufficient application of organic, mineral fertilizers, ameliorants, pollution, etc. The soils of Ukraine are degrading (the annual

increase in eroded lands amounts to 80–90 thousand hectares). The same problems exist at the regional level, in particular in the Kiev region.

In the structure of the land fund of Kiev region in 2017 compared to 2005 there were changes – the share of farmland decreased from 64.2 to 59.0%, that is, their total area decreased by 148.9 thousand hectares, or by 8.2% due to the loss of arable land and hayfields, which turned out to be unproductive or flooded lands. It is determined that the quality and potential of land resources of the Kiev region rather

uneven. Climatic zoning of the Kiev region. causes a significant difference in levels of bonitet by district. So, better fertility agricultural land located within the Southern Polissya, less fertile – in the northern part of the Forest-Steppe and the worst – within the North-Western Polissya.

The results obtained on the basis of our proposed methodological approach to the environmental and economic assessment of the potential of agricultural land in the administrative districts of the Kiev region are given in Table 1.

Table 1. Ecological and economic assessment of the potential of agricultural land areas of Kiev region

Region	Agroclimatic potential, ball	Bonitet of the soil, ball	Normative-monetary land valuation thousand UAH	Integral index, ball
Baryshevsky	7.1	48	11.7	49.0
Bila Tserkva	7.4	59	35.7	91.1
Boguslavsky	7.2	52	34.6	82.5
Borispolsky	6.3	40	11.7	35.2
Borodyansky	4.2	27	9.9	2.7
Brovarsky	5.0	27	13.3	14.9
Vasylkivsky	5.2	60	34.6	68.9
Vyshhorodsky	5.0	29	13.3	16.4
Volodarsky	7.4	58	35.7	90.4
Zgurovsky	4.0	60	22.1	40.9
Ivankivsky	4.8	26	9.9	7.8
Kagarlyk	5.7	68	34.6	79.7
Kiev Svyatoshinsky	5.0	32	18.6	25.5
Makarivsky	5.7	30	18.6	30.9
Myronivsky	5.7	63	34.6	76.0
Obukhovsky	5.0	62	34.6	68.4
Pereyaslav-Khmelnytsky	5.3	55	22.1	50.0
Polissky	4.9	28	9.9	10.3
Rokitnyansky	7.4	69	35.7	98.5
Skvirsky	7.4	63	35.7	94.1
Stavyshchensky	7.3	62	35.7	92.4
Taraschansky	7.3	60	35.7	90.9
Tetyevsky	7.3	71	35.7	99.0
Fastovsky	7.4	53	18.6	64.6
Yagotinsky	4.0	66	10.7	30.7

Source: Calculated by the author according to the Institute of Soil Conservation of Ukraine, the Ukrainian Hydrometeorological Center and the State Service of Ukraine on geodesy, cartography and cadaster.

The basis for calculating indicators of the use of the potential of agricultural land of the Kiev region. It is proposed to consider the gross crop production per 1 ha of agricultural land in comparable prices of 2010 (Table 2). Using correlation and regression analysis revealed a positive relationship between these indicators (correlation coefficient – 0.52).

The data Table. 2 indicate that the level of agricultural production per ball-hectare of the potential of agricultural land of the Kiev region ranges from 37.5 UAH / ball-hectare – in Volodarsky region to 476.5 – in Brovarsky. However, high potential is not always the key to an effective result. For example, in Tetyevsky region, according to a high rate of

bonitet and integrated assessment, only UAH 47.4 is made per 1 hectare potential of agricultural land.

It is proved that the efficiency of land use should be determined, first of all, not by the volume of land area received per unit, but by the level of realization of the potential of the land as a basic resource of agricultural production. Therefore, based on the theoretical approaches of Plotnyk [7] to assess the potential of agricultural land on the basis of the natural potential of the soil and the agrosoil potential of natural and effective fertility and research Hulinchuk [3] on the potential efficiency of agricultural production

is proposed to determine the theoretical level of gross agricultural output per unit area of agricultural land ( $VP_t$ ):

$$VP_t = \sum_{j \in k} V_k P_{jk} S_{jk}, \quad (3)$$

where  $S_{jk}$  – the area of agricultural land of the  $j$ -th species with  $k$ -th type of their intended use;

$P_{jk}$  – productivity of agricultural land of the  $j$ -th type at  $k$ -th type of their intended use;

$C_k$  – cost estimation of the products obtained in the  $k$ -th type of targeted use of agricultural land.

Table 2. The efficiency of use of agricultural land areas of the Kiev region per unit of their potential

Region	Gross output of crop production for 2012–2017 at constant prices in 2010, UAH/ha	Integral index of agricultural land potential	Production of crop production UAH / hectare, in terms of:			
			1 ball integral assessment	thousand UAH normative monetary valuation	1 ball of the bonitet	1 ball climatic potential
2	3	4	5	6	7	8
Baryshevsky	4,111.1	49.0	83.9	351.4	85.6	579.0
Bila Tserkva	4,603.8	91.1	50.5	129.0	78.0	622.1
Boguslavsky	4,150.9	82.5	50.3	120.0	79.8	576.5
Borispol'sky	3,533.1	35.2	100.2	302.0	88.3	560.8
Borodyansky	990.5	2.7	366.7	100.1	36.7	235.8
Brovar'sky	7,117.4	14.9	476.5	535.1	263.6	1,423.5
Vasylkiv'sky	4,231.9	68.9	61.5	122.3	70.5	813.8
Vyshhorod'sky	3,900.0	16.4	237.5	293.2	134.5	780.0
Volodarsky	3,391.9	90.4	37.5	95.0	58.5	458.4
Zgurov'sky	4,661.0	40.9	113.8	210.9	77.7	1,165.2
Ivankiv'sky	601.2	7.8	76.7	60.7	23.1	125.3
Kagarlyk	4,950.5	79.7	62.1	143.1	72.8	868.5
K. Svyatoshinsky	1,657.0	25.5	65.0	89.1	51.8	331.4
Makariv'sky	1,938.9	30.9	62.8	104.2	64.6	340.2
Myroniv'sky	4,267.5	76.0	56.2	123.3	67.7	748.7
Obukhov'sky	3,456.3	68.4	50.5	99.9	55.7	691.3
Pereyaslav-Khmelnytsky	3,909.3	50.0	78.2	176.9	71.1	737.6
Polissky	1,123.3	10.3	109.0	113.5	40.1	229.2
Rokitnyansky	4,861.5	98.5	49.3	136.2	70.5	657.0
Skvir'sky	5,731.5	94.1	60.9	160.5	91.0	774.5
Stavyshchensky	4,439.2	92.4	48.1	124.3	71.6	608.1
Taraschansky	4,469.9	90.9	49.2	125.2	74.5	612.3
Tetyev'sky	4,692.8	99.0	47.4	131.5	66.1	642.9
Fastov'sky	5,018.0	64.6	77.7	269.8	94.7	678.1
Yagotinsky	5,010.8	30.7	163.4	468.3	75.9	1,252.7

Source: calculated by the author according to the State Institute of Soil Protection of Ukraine, the Ukrainian Hydrometeorological Center and the State Statistics Service of Ukraine.

In order to determine the effectiveness of the use of the potential of agricultural land, we

propose to compare the indicator of the theoretical level of gross crop production with the actual data of this indicator per 1 point of the integral index of the potential of agricultural land calculated by the author's methodology (Table 3).

Table 3. The level of effectiveness of the use of the potential of agricultural land in the regions of Kiev region

Region	Volume of gross crop production per 1 ball of integral estimation, UAH		Level of potential use, %
	Actually	Theoretically	
Baryshevsky	4.11	2.96	138.7
Bila Tserkva	4.60	3.70	124.6
Boguslavsky	4.15	3.21	129.5
Borispolsky	3.53	2.92	121.2
Borodyansky	0.99	2.43	40.7
Brovarsky	7.12	2.42	293.8
Vasylkivsky	4.23	3.59	118.0
Vyshhorodsky	3.90	2.63	148.0
Volodarsky	3.39	4.14	82.0
Zgurovsky	4.66	3.37	138.2
Ivankivsky	0.60	1.89	31.8
Kagarlyk	4.95	4.38	113.0
K. Svyatoshinsky	1.66	3.05	54.4
Makarivsky	1.94	2.33	83.2
Myronivsky	4.27	3.75	113.8
Obukhovsky	3.46	3.97	87.1
P.-Khmelnitsky	3.91	3.09	126.6
Polissky	1.12	2.02	55.7
Rokitnyansky	4.86	5.74	84.7
Skvirsky	5.73	3.42	167.5
Stavyschensky	4.44	4.11	107.9
Taraschansky	4.47	3.85	116.2
Tetyevsky	4.69	3.91	119.9
Fastovsky	5.02	3.34	150.1
Yagotinsky	5.01	3.27	153.4

Source: author's calculations.

The highest level of use of the potential of agricultural land is observed in Brovary region – 293.8%. The next 16 regions demonstrate a rather high level of potential use from 107.9 to 167.5%. Such indicators of the level of performance, which exceed the theoretical values of the efficiency of the use of the potential of agricultural land, prove that this is due to the introduction of intensive technologies and not the natural (potential) fertility of lands. This fact in turn provokes a loss of soil fertility their degradation and pollution. However 8 regions currently use

insufficiently the potential of agricultural land the worst being Ivankovsky. Borodyansky and Kiev-Svyatoshynsky.

## CONCLUSIONS

Thus, on the basis of an improved methodological approach to the environmental and economic assessment of the potential of agricultural land, an analysis of the integral index of this indicator has been carried out, has shown the practical ability of this approach at the regional level. It turned out that the majority of areas with high potential of agricultural land had a low indicator of output per 1 hectare.

The proposed approach provided for comparing the cost estimates of the theoretical and actual productivity of land resources in agriculture, calculated on the integral score of the potential of agricultural land.

In general, the problem of rational use of the potential of agricultural land depends on many factors. This raises the need for an integrated approach to the organization of an effective system of using the potential of land in modern conditions of economic activity.

## REFERENCES

- [1]Berezin, O.V., Plotnyk, O.D., 2012, Ekonomichnyj potentsial ahrarykh pidpryemstv: mekhanizmy formuvannya ta rozvytku [The economic potential of agricultural enterprises: the mechanisms of formation and development]. Poltava: InterHrafika, p. 17-25.
- [2]De Olde, E.M., Moller, H., Marchand, F., McDowell, R.W., MacLeod, C.J., Sautier, M., Halloy, S., Barber, A., Bengé, J., Bockstaller, C., Bokkers, E.A.M., de Boer, I.J.M., Legun, K.A., Le Quellec, I., Merfield, C., Oudshoorn, F.W., Reid, J., Schader, C., Szymanski, E., Sørensen, C.A.G., Whitehead, J., Manhire, J., 2017, When experts disagree: the need to rethink indicator selection for assessing sustainability of agriculture. *Environment, Development and Sustainability*, 19(4), p. 1327-1342.
- [3]Hulinchuk, R.M., 2015, Metodichni osnovy otsiniuvannya potentsialu zemel' sil'skohospodars'koho pryznachennia [Methodical framework for assessing the potential of agricultural land]. *Balanced Nature Using*, 2: 107–113.
- [4]Lup, A., Miron, L., Alim, I.D., 2016, Management of land resource, agricultural production and food security. *Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development"*, 16(2), 219-228.

[5]Manos, B., Papathanasiou, J., Bournaris, T., Voudouris K., 2010, A multicriteria model for planning agricultural regions within a context of groundwater rational management. *Journal of Environmental Management*, 91: 1593-1600.

[6]Meyer-Aurich, A., Zander, P, Werner, A., Reinhold, R., 1998, Agricultural land use strategies appropriate to nature conservation goals and environmental protection. *Landscape and Urban Planning*, 41: 119-127.

[7]Plotnyk, O.D., 2012, Osoblyvosti strukturyzatsii ekonomichnoho potentsialu ahrarnykh pidpriemstv [Features of structuring the economic potential of agricultural enterprises]. *Technological audit and production reserves*, 1 (3): 43–48.

