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ASSESSMENT OF ECONOMIC LOSSES CAUSED BY DEGRADATION PROCESSES OF AGRICULTURAL LAND USE

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Abstract

The instability and excessive intensity of modern agriculture's systems are the result of a number of unresolved environmental and economic problems. The main purpose of our study is to assess the economic losses caused by degradation processes within the research facility. Comparing the current cost of future losses from unreceived agricultural products by years while maintaining the existing rate of land degradation, which is 1070.45 thousand UAH, with the total cost of CAOT on erosion-hazardous areas within Kamyanobrid village council Lysyansky district of Cherkasy region - 798.85 thousand UAH, it is possible to determine the economic efficiency of land protection measures in the long run, which is equal to 271.60 thousand UAH, because the arrangement of CAOT elements allows to preserve the existing state of land resources, stop degradation processes and prevent reduction of agricultural production.

Key words: *economic losses, degradation processes, land use, agricultural land, land degradation.*

INTRODUCTION

The instability and excessive intensity of modern agriculture's systems are the result of a number of unresolved environmental and economic problems. As a result of reorganization of land use of agricultural organizations, the current state of agricultural production is in crisis, primarily due to the fact that land distribution was carried out without ecological and landscape justification, therefore, erosion resistance of territories was broken, land management projects regarding the formation crop rotation are not developed, the balance of individual elements of agro landscapes is disturbed, including the ratio of area arable land, natural lands, forest and water resources, etc. (Openko, 2019; Openko, 2019).

As a result of the use of inefficient approaches to the organization of the territory, there is soil compaction, loss of humus and imbalance of soil nutrients, which leads to reduced soil fertility and land degradation. Thus, in Ukraine, the annual losses of crop production from land degradation exceed 9-12 million tons of grain, and the total loss reaches more than $ 10 billion per year, which hinders the economic development of the state (Ievsiukov, Openko, 2014; Kryvoviaz et al., 2020; Tarariko, 1998).

MATERIALS AND METHODS

According to Krasnianska O.V. (2011), ecological and landscape organization of the territory is a set of land management measures or actions that lead to the formation or ordering of a concrete part of the earth's surface (land tenure, land use) with the establishment on it the order of land use, as well provide as creating a stable, sustainable, capable to self-reproduction of the landscape with their own unique properties (optimal ratio of lands, structure of crops, etc.) with appropriate specific production, social and environmental goals.

Recently, significant development received the adaptive-landscape approach has been significantly developed, which is carried out taking into account the category of agro-landscape and its main morphological units (Kiryushin, 2000).

Implementation of the landscape approach is realized with the help of soil protection system of agriculture with contour-ameliorative organization of the territory (here in after CAOT), which provides the most rational use of land resources, as well as protection of soils from degradation (Martyn et al., 2019; Openko et al., 2020; Openko et al., 2020; Openko et al., 2019).

The essence of the CAOT is to bring the existing agro landscape to the appropriate environmental requirements through the differentiated use of land resources; more complete consideration of the strip structure of natural complexes; contour organization of land use territory; creation of a field hydrographic network by introducing permanent anti-degradation measures into the agroecosystem (different types of water regulating shafts, creation of meadows on watercourses, creation field protective forest belts); application of soil protection methods of tillage; of optimization of ratio in agro landscapes of intensive agriculture, natural phytocenoses and water spaces (Tarariko, 1990).

According to Shvebs H. I. (1985), the basis of the CAOT is the differentiated use of arable land, taking into account the terrain by dividing them into three ecological and technological groups (hereinafter ETG).

The first ETG includes arable land with full-profile and weakly eroded soils located on the plateau and slopes up to 3°, the nature of the terrain and the quality condition of which allows to place grain-row crop rotations, if necessary, with optimal allowable saturation with sugar beets, corn and sunflower.

The second ETG includes arable land located on slopes from 3° to 5° in a complex with weakly and average eroded soils, where soil protective grain-grass and grass-grain crop rotations with complete exclusion of row crops are design. Restoration of soil fertility is carried out due to saturation of crop rotations with perennial grasses (up to 50% and more), application of maintenance doses of fertilizers and introduction of soil-protective technologies of soil cultivation.

The lands of third ETG include slopes with a steepness of more than 5°, with medium- and strongly-eroded soils, where it is difficult to perform basic technological operations of cultivation of even grain crops. It is expedient to remove them from composition of arable land permanently, followed by creation of meadows or afforestation (Shelyakin et al., 1990; Shvebs, 1985).

The essence of the division of arable land into ecological and technological groups is the differentiated use of land resources and crops by optimizing the structure of sown areas and crop rotations, taking into account the ratio of technological groups of land.

The main purpose of our study is to assess the economic losses caused by degradation processes within the research facility on the example of Kamyanobrid village council of Lysyansky district of Cherkasy region (Figure 1).

RESULTS AND DISCUSSIONS

Using scientific developments N.M. Sheliakin, V.A. Belolipskyi ta I.N. Holovchenko (1990) taking into account the change in the value of soil erosion coefficient depending on the terrain (slope steepness and slope length) (Figure 2), the forecast of land use dynamics in the study area for the next 50 and 100 years was determined (Figures 3 and 4).

The analysis of the obtained results showed that further use of lands without a system of land protection measures will increase the area of eroded lands in relation to non-eroded ones. There will be observed a decline in soil quality, which will lead to a loss of ecological balance of the agro landscape.

Ukraine State Service of Geodesy, Cartography and Cadastre annually by the consumer price index for the previous year calculates the coefficient of the indexation of regulatory monetary value of land, which is indexed normative monetary valuation of land and land. The calculation is carried out according to the formula:

$$Ki = i: 100, \quad (1)$$

where: i - consumer price index for the previous year.

The use of coefficients of indexation of monetary valuation of land (3.2) for the valuation of arable land (1.756) allowed establishing the normative monetary valuation of 1 ha of arable land of Zhashkiv natural-agricultural district of

Cherkasy region (Letter from the State Agency of Land Resources of Ukraine, 2014; Resolution of the Cabinet of Ministers of Ukraine, 2011). Predicting the indicators of land valuation, using the scores of soil quality, for 50 and 100 years, the level of depreciation of arable land was determined (Table 1).

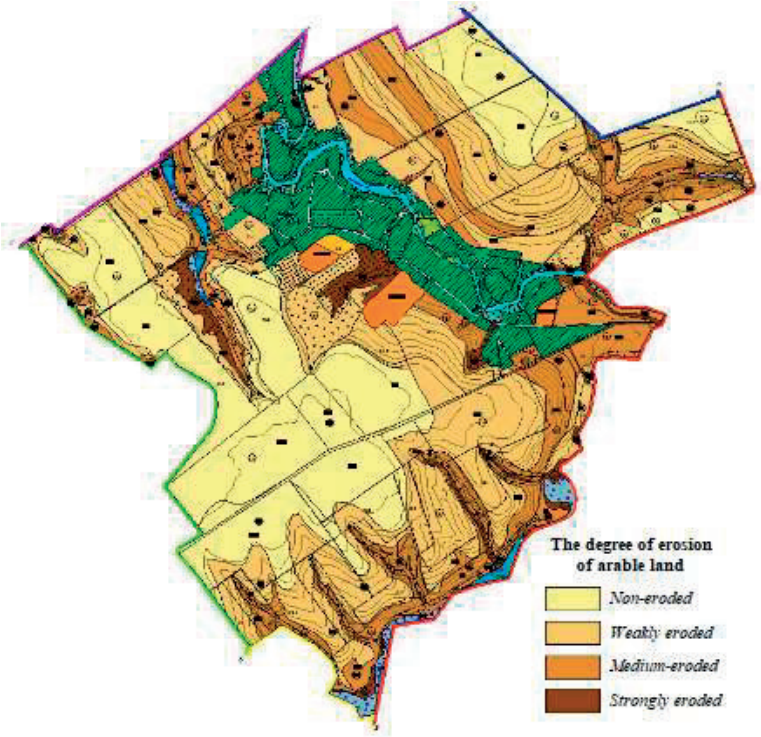

Figure 1. The current state of land resources of Kamyanobrid village council of Lysyansky district of Cherkasy region
Source: own developments

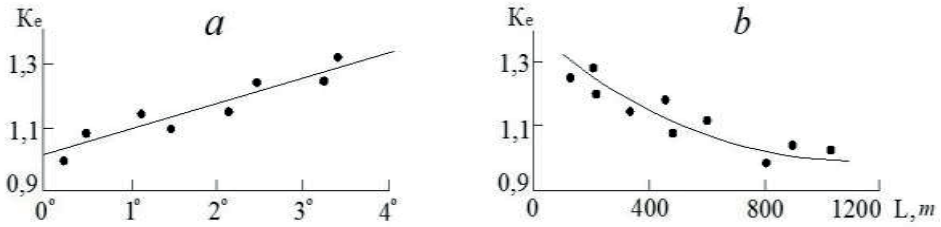

Figure 2. Change in the value of the coefficient of erosion of the soil cover (Ke) depending on:
a) the slope; b) slope lengths (Openko, 2019)

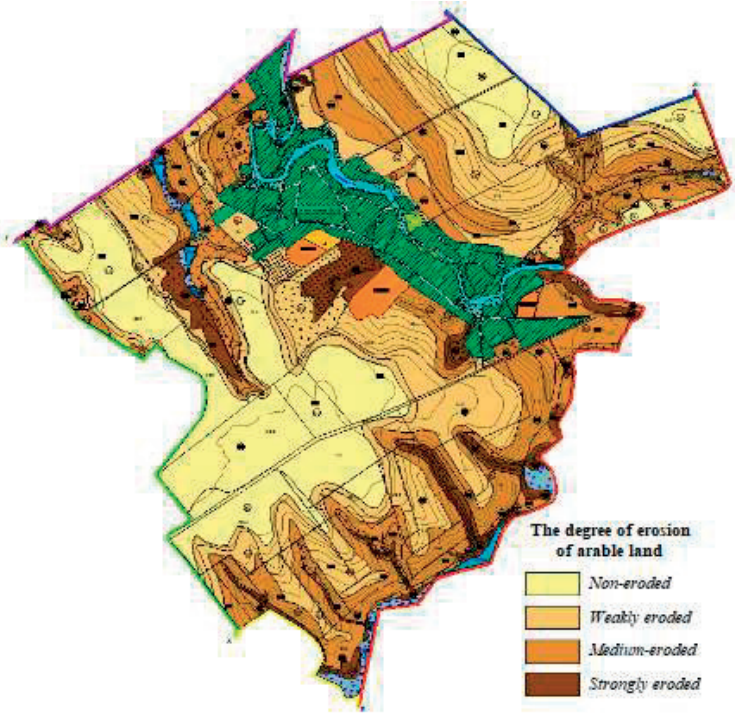

Figure 3. Geoinformation model of the state of land resources of Kamyanobrid village council of Lysyansky district of Cherkasy region in 50 years. Source: own developments

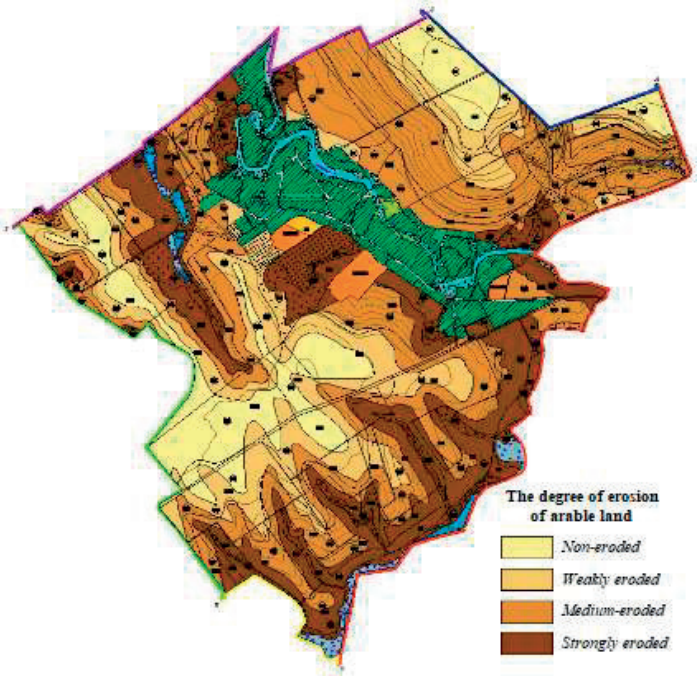

Figure 4. Geoinformation model of the state of land resources of Kamyanobrid village council of Lysyansky district of Cherkasy region in 100 years. Source: own developments

Table 1. Monetary valuation of arable lands of Kamyanobrid village council of Lysyansky district of Cherkasy region

Codes of agricultural groups of soils	Area agricultural groups of soils, ha	Scores of quality of agricultural groups of soils	The general score of quality in the natural-agricultural area (NAA) 06 of Cherkasy region	Normative monetary value of 1 ha of arable land of Zhashkiv NAA, UAH	Normative monetary value of 1 ha of agricultural soil group, UAH	Normative monetary valuation of the entire area of the agricultural group of soils, UAH
The existing cost of arable land						
209d	93.1	82	71	34288.36	39600.64	3686819.69
41d	613.3	67			32356.62	19844315.91
40d	10.9	64			30907.82	336895.21
55g	824.2	61			29459.01	24280118.94
52g	363.0	53			25595.54	9291179.69
49d	104.6	53			25595.54	2677293.10
50d	23.8	41			19800.32	471247.63
57g	58.7	37			17868.58	1048885.76
56g	237.6	32			15453.91	3671848.71
139d	6.6	24			11590.43	76496.85
141	21.9	14			6761.09	148067.76
215d	8.7	9			4346.41	37813.78
Total	2366.4					65570983.05
The cost of arable land in 50 years						
209d	67.10	82	71	34288.36	39600.64	2657203.02
41d	514.10	67			32356.62	16634539.07
40d	8.40	64			30907.82	259625.67
55g	690.00	61			29459.01	20326719.33
52g	281.70	53			25595.54	7210262.59
49d	167.60	53			25595.54	4289811.89
50d	35.30	41			19800.32	698951.32
57g	119.20	37			17868.58	2129934.97
56g	395.90	32			15453.91	6118202.47
139d	14.40	24			11590.43	166902.21
141	48.00	14			6761.09	324532.08
215d	24.70	9			4346.41	107356.37
Total	2366.4					60924040.98
The cost of arable land in 100 years						
209d	38.00	82	71	34288.36	39600.64	1504824.36
41d	372.90	67			32356.62	12065784.12
40d	2.50	64			30907.82	77269.54
55g	584.50	61			29459.01	17218793.40
52g	193.9	53			25595.54	4962974.50
49d	182.8	53			25595.54	4678864.04
50d	52.40	41			19800.32	1037536.80
57g	198.20	37			17868.58	3541552.95
56g	494.70	32			15453.91	7645048.65
139d	31.50	24			11590.43	365098.59
141	152.40	14			6761.09	1030389.36
215d	62.60	9			4346.41	272085.38
Total	2366.4					54400221.7

Source: own calculations according to (Shvebs, 1985)

The calculation showed that as a result of the negative impact of degradation processes on the agro-landscape, the monetary value of arable land will decrease by UAH 6.52 million in 50 years, and in 100 years it will decrease by UAH 11.17 million. The production direction of the farm of Kamyanobrid village council is grain and beet with developed animal husbandry, and the specialization is aimed at growing such crops as: winter wheat, sugar beets, winter rye, corn for grain, barley and oats (Table 4). After calculating the amount of unreceived agricultural products, through the score of the quality of major crops, it was found that the damage caused to land by degradation significantly affects the yield of gross agricultural output in the farm. The projected gross agricultural products in 50 years will decrease by 8664.6 quintals, in 100 years the losses will be 36444.2 quintals. Using the statistical data of the State Statistics Service of Ukraine - the average sales prices of agricultural products, installed the size of sales of crop products, both actual and projected for 50 and 100 years.

Using the data from Table 2, namely, the size of sales of crop products, determined the loss from unreceived crop products by year. From these calculations it follows that in 100 years will receive than 4.1 million UAH less agricultural products, and in the amount for 100 years - 168.8 million UAH (Figure 5). Losses from unreceived agricultural products on crops of Kamyanobrid village council are reflected in Table 3.

Table 3. Discounting the value of unreceived agricultural products of Kamyanobrid village council of Lysyansky district of Cherkasy region for a period of 100 years*

Years	Gross output, thousand UAH	The cost of unreceived products, UAH / year	Coefficient discount rate (at a discount rate of 1.167)	The current value of unreceived , UAH	Years	Gross output, thousand UAH	The cost of unreceived products, UAH / year	Coefficient discount rate (at a discount rate of 1,167)	The current value of unreceived, UAH
1	26709.44	-25568.0	1.167	-21909.2	51	25399.89	-1335121.2	2633,987	-506.9
2	26683.87	-51136.0	1.362	-37547.8	52	25343.17	-1391842.6	3073,863	-452.8
3	26658.30	-76704.0	1.589	-48262.0	53	25286.44	-1448563.9	3587,198	-403.8
4	26632.74	-102272.0	1.855	-55140.8	54	25229.72	-1505285.3	4186,260	-359.6
5	26607.17	-127840.0	2.164	-59062.6	55	25173.00	-1562006.6	4885,366	-319.7
6	26581.60	-153408.0	2.526	-60732.7	56	25116.28	-1618728.0	5701,222	-283.9
7	26556.03	-178976.0	2.948	-60715.4	57	25059.56	-1675449.3	6653,326	-251.8
8	26530.46	-204544.0	3.440	-59459.3	58	25002.84	-1732170.7	7764,431	-223.1
9	26504.90	-230112.0	4.015	-57319.4	59	24946.12	-1788892.0	9061.091	-197.4
10	26479.33	-255680.0	4.685	-54574.3	60	24889.39	-1845613.4	10574.294	-174.5
11	26453.76	-281248.0	5.467	-51441.1	61	24832.67	-1902334.7	12340.201	-154.2
12	26428.19	-306816.0	6.380	-48087.0	62	24775.95	-1959056.1	14401.014	-136.0
13	26402.62	-332384.0	7.446	-44639.5	63	24719.23	-2015777.4	16805.983	-119.9
14	26377.06	-357952.0	8.689	-41193.9	64	24662.51	-2072498.7	19612.583	-105.7
15	26351.49	-383520.0	10.141	-37820.3	65	24605.79	-2129220.1	22887.884	-93.0
16	26325.92	-409088.0	11.834	-34568.7	66	24549.07	-2185941.4	26710.161	-81.8
17	26300.35	-434656.0	13.810	-31473.2	67	24492.34	-2242662.8	31170.757	-71.9
18	26274.78	-460224.0	16.117	-28555.8	68	24435.62	-2299384.1	36376.274	-63.2
19	26249.22	-485792.0	18.808	-25828.8	69	24378.90	-2356105.5	42451.112	-55.5
20	26223.65	-511360.0	21.949	-23297.5	70	24322.18	-2412826.8	49540.447	-48.7
21	26198.08	-536928.0	25.615	-20961.8	71	24265.46	-2469548.2	57813.702	-42.7
22	26172.51	-562496.0	29.892	-18817.4	72	24208.74	-2526269.5	67468.590	-37.4
23	26146.94	-588064.0	34.884	-16857.6	73	24152.02	-2582990.9	78735.845	-32.8
24	26121.38	-613632.0	40.710	-15073.3	74	24095.30	-2639712.2	91884.731	-28.7
25	26095.81	-639199.9	47.509	-13454.4	75	24038.57	-2696433.6	107229.481	-25.1
26	26070.24	-664767.9	55.442	-11990.2	76	23981.85	-2753154.9	125136.804	-22.0
27	26044.67	-690335.9	64.701	-10669.6	77	23925.13	-2809876.2	146034.650	-19.2
28	26019.10	-715903.9	75.506	-9481.4	78	23868.41	-2866597.6	170422.437	-16.8
29	25993.54	-741471.9	88.116	-8414.7	79	23811.69	-2923318.9	198882.984	-14.7
30	25967.97	-767039.9	102.831	-7459.2	80	23754.97	-2980040.3	232096.442	-12.8
31	25942.40	-792607.9	120.004	-6604.8	81	23698.25	-3036761.6	270856.548	-11.2
32	25916.83	-818175.9	140.045	-5842.2	82	23641.52	-3093483.0	316089.592	-9.8
33	25891.26	-843743.9	163.432	-5162.6	83	23584.80	-3150204.3	368876.554	-8.5
34	25865.70	-869311.9	190.726	-4557.9	84	23528.08	-3206925.7	430478.938	-7.4
35	25840.13	-894879.9	222.577	-4020.5	85	23471.36	-3263647.0	502368.921	-6.5
36	25814.56	-920447.9	259.747	-3543.6	86	23414.64	-3320368.4	586264.531	-5.7
37	25788.99	-946015.9	303.125	-3120.9	87	23357.92	-3377089.7	684170.707	-4.9
38	25763.42	-971583.9	353.747	-2746.6	88	23301.20	-3433811.0	798427.215	-4.3
39	25737.86	-997151.9	412.823	-2415.4	89	23244.48	-3490532.4	931764.560	-3.7
40	25712.29	-1022719.9	481.764	-2122.9	90	23187.75	-3547253.7	1087369.242	-3.3
41	25686.72	-1048287.9	562.218	-1864.6	91	23131.03	-3603975.1	1268959.905	-2.8
42	25661.15	-1073855.9	656.109	-1636.7	92	23074.31	-3660696.4	1480876.210	-2.5
43	25635.58	-1099423.9	765.679	-1435.9	93	23017.59	-3717417.8	1728182.536	-2.2
44	25610.02	-1124991.9	893.548	-1259.0	94	22960.87	-3774139.1	2016789.020	-1.9
45	25584.45	-1150559.9	1042.770	-1103.4	95	22904.15	-3830860.5	2353592.786	-1.6
46	25558.88	-1176127.9	1216.913	-966.5	96	22847.43	-3887581.8	2746642.782	-1.4
47	25533.31	-1201695.9	1420.137	-846.2	97	22790.70	-3944303.2	3205332.126	-1.2
48	25507.74	-1227263.9	1657.300	-740.5	98	22733.98	-4001024.5	3740622.591	-1.1
49	25482.18	-1252831.9	1934.069	-647.8	99	22677.26	-4057745.9	4365306.564	-0.9
50	25456.61	-1278399.9	2257.058	-566.4	100	22620.54	-4114467.2	5094312.760	-0.8
Всього		32599197.5		1066013.3			136239711.1		4437.9
Losses from unreceived products for 100 years, UAH								168838908.6	
The real value of future losses from unreceived products in prices 2014, UAH								1070451.2	

Source: own calculations

The above data - UAH 168.8 million (see Table 2) are projected funds in 100 years, to actually reflect the damage caused by unreceived agricultural products, we need to determine how much they will cost now. In order to recalculation future income as of today, the mechanism of discounting cash flows is used all over the world, i.e. bringing future cash flows to the present time. The application of the cash flow discounting approach is based on the discount rate (capitalization), which allows you to set the real value of future losses. The discount rate (capitalization) can be determined by such approaches as element-by-element method, extraction method; the method of related investments, the method of cumulative construction (the method of "summation of risks"), the method of Elwood (Dekhtyarenko

et al., 2002). In this case, we use the method of cumulative construction, which is calculated through the product of the risk-free rate and the risk of agriculture. The risk-free rate is formed as the average for the year for business entities in foreign currency on foreign currency deposits and commercial banks and is 7.5%. The risk of agriculture is based on the rate of agricultural insurance, for Cherkasy region. The minimum insurance rates for insurance of crops with state support is 9.2%. According to the above data, the coefficient discount rate (capitalization) for agricultural land is 1.167. Taking into account the discount rate, the real value of future losses of the studied territory was determined, which in total of 100 years amounted to UAH 1.07 million.

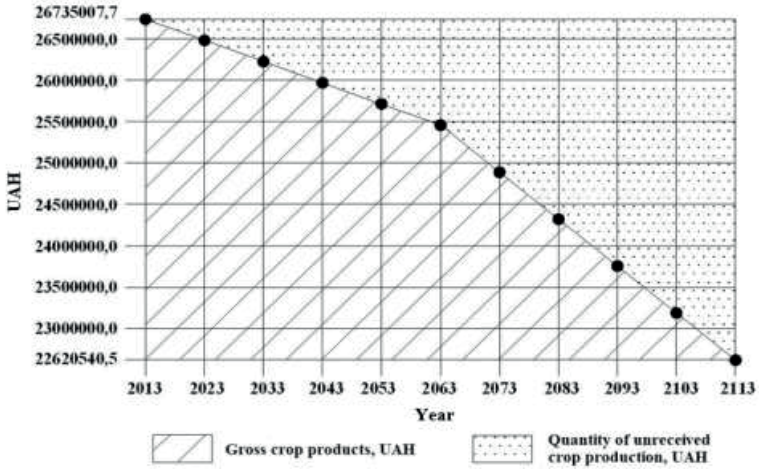

Figure 5. Reduction of agricultural production within the Kamyanobrid village council of Lysyansky district of Cherkasy region while maintaining degradation processes. Source: own calculations.

Table 4. Unreceived agricultural products by cultures of Kamyanobrid village council*

№ п/п	Cultures	Area, ha	The actual size of sales of crop products, UAH	Project size of sales of crop products, UAH (in 50 years)	Project size of sales of crop products, UAH (in 100 years)	Losses from unreceived products for 100 years, UAH
1.	Winter wheat	887.1	8745195.7	8185951.6	7384787.9	62652603.9
2.	Sugar beets	392.8	9472913.0	9348327.9	8374251.1	34245133.5
3.	Winter rye	265.4	1322732.7	1220748.0	1136679.9	9843581.4
4.	Corn for grain	389.2	4803654.2	4529020.3	3745257.1	40720821.1
5.	Barley	280.9	1720865.4	1557510.7	1391581.7	16564469.3
6.	Oat	151.0	669646.7	615049.3	587982.8	4812299.4
Total		2366.4	26735007.7	25456607.8	22620540.5	168838908.6

Source: own calculations.

Based on the above indicates, the need to implement measures to stop degradation processes, as well as to preserve and increase soil fertility is not in doubt. The introduction of the CAOT will contribute to the optimization of lands and the preservation of agro landscape.

CONCLUSIONS

Comparing the current cost of future losses from unreceived agricultural products by years while maintaining the existing rate of land degradation, which is 1070.45 thousand UAH, with the total cost of CAOT on erosion-hazardous areas within Kamyanobrid village council Lysyansky district of Cherkasy region - 798.85 thousand UAH, it is possible to determine the economic efficiency of land protection measures in the long run, which is equal to 271.60 thousand UAH, because the arrangement of CAOT elements allows to preserve the existing state of land resources, stop degradation processes and prevent reduction of agricultural production. The productivity of the agro-landscape depends on the one hand on the soil, relief and other natural

and climatic conditions, and on the other hand on the human factor, i.e. on the technology of land use, the introduction of various anti-degradation measures and so on. Therefore, in modern conditions, rational and efficient use of agricultural land involves the implementation of the principle of natural-agricultural adaptability, which is to systematically take into account the natural properties and socio-economic characteristics of land use. Agricultural production should be organized in accordance with the landscape structure of the area, ie should take into account the natural morphological structure of agro landscapes, while maintaining their ability to self-reproduction and natural stabilization.

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