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# HUMAN INDUCET DECREASE OF HUMUS CONTENT IN SOILS OF STEPPE LANDSCAPES (KIROVOGRAD REGION, UKRAINE)

## *UBYTEK ZAWARTOŚCI HUMUSU W GLEBACH STEPOWYCH SPOWODOWANY CZYNNIKIEM ANTROPOGENICZNYM (REGION KIROWOGRADCKI, UKRAINA)*

**Key words**: soil, Kirovograd region, humus, dynamic, human impact

***Słowa kluczowe:*** *gleby, Kirovograd region, humus, dynamika, wpływ antropogeniczny*

**Abstract**

The dynamics of humus in soils of Kirovograd province, Ukraine from 1882 till 2010 is analyzed. During the last 130 years the content of organic matter in soils of studied area decreased from 5.5 to 4.1 percent. Dehumification of the soils is caused mainly by anthropogenic factor. In order to increase the humus content in soils change of the proportion of types of tillage, use of scientifically based structure acreage and crop rotation, cultivation of more perennial grasses and reforestation of slopes are recommended.

***Streszczenie***

*Region Kirowogradcki położony w obrębie Ukrainy Centralnej cechuje się występowaniem żyznych czarnoziemów. Przeanalizowano zmiany zawartości humusu w glebach regionu za okres od 1882 po 2010 rok. Ustalono, że jego ilość w glebie (uśredniona – z różnych miejsc regionu) w przeciągu ostatnich 130 lat zmniejszyła sie z 5,5 do 4.1%. Autorka analizuje przyczyny obniżenia zawartości humusu w glebach regionu oraz jego skutki.*

## INTRODUCTION

The soil is a main branch of biosphere and it is the center of the concentration of the organic matter. The fertility is its main property. The humus has the main role in nutrient. The structure, water and physical property, absorbing property, fermentative activities are depending on humus. Such as humus is created from plant and it's a form of accumulation sun energy, so its saving must arrive from the organic matter. But its exploration tells us about great losing organic matter in Ukrainian soils. We are losing humus now because we didn't have good laws for using the land, we didn't use definite dose of fertilizers and chemicals, and we continue increasing agricultural areas. Because of taking some part of plant production without return, our soils lose organic matter and degrade step by step (Zhukov, 1981).

## ANALYSIS OF PREVIOUS RESEARCHES AND PUBLICATIONS

The humus content in the soil and its properties was studied by many prominent scientists, including I.V. Tyurin, V. V. Ponomarev, M. M. Kononov, D.S. Orlov. The first who assessed the humus as a source of nutrients was J. Liebig. He determined how many nutrients are found in plants, therefore, the amount of them was consumed from the soil. It turned out not so much when the average yield of crops per hectare submitted: 19-40 kilo of nitrogen, 8-14 kilo of phosphorus (calculated on phosphorus oxide), 22-40 kilo of potassium. At the same time in 20 centimeters of topsoil per hectare contains 3-11 tons of nitrogen, 20-40 tons of potassium, 400 kilo of phosphorus. However, not all of this substance is readily available to plants: part of them is in dissolved form. But the connection which is associated with humus (particularly nitrogen) least accessible: they are less soluble than mineral nitrogen compounds.

On average 600-700 kilo of humus podzolic soils and to some tons per hectare in black soils disappear from the soil during the year. As the reserves of humus on one hectare to layer up to 20 centimeters of podzolic soils is 60 tons, and for black soils – 130-220 tons, then obviously existing stocks of humus in the soil hectare, if it will not recover, only enough for one hundred years. But it comes only on the basis of a simple arithmetic calculation. The situation is much more complicated. Firstly, the humus in the soil is continuously formed again. Secondly, nutrients of the humus are inactive, and their release does not increase significantly the total content available substances in the soil. Thirdly, the harvest (for example) declines the podzolic soils for five or six years, if the soil is not fertilized, despite the fact that the humus content has not changed. Fourthly, although the manure increases the crop of the plants, but even when it is made in the amount of 20 tons per hectare, it disappears within 3-4 years. Even 15-years manure does not increase or increases very little content in the soil humus.

The academician D.N. Pryanishnikov, based on the long analysis of the use of the organic fertilizers, found that only the organic matter manure does not increase the

yield. But increasing the crop is possible only with the help of nitrogen, phosphorus, potassium, which are contained in organic matter. In addition, the introduction of a fertilizers for crops may increase the humus content in the soil for several decades. This increasing causes better development of plants and their roots in the soil. After harvesting the crop residues decompose, becoming partly to humus.

The hypothesis flashed in the scientific literature, that not the humus increases the yield, but only the organic matter. Earning the ground plant residues (weed, specifically sown grasses, such as lupine), you can have for the second year after the development of humus devoid breed to get high yields of crops. This method is called "sideration" - green manure soil. High yields of crops when sideration is associated with improving the physical properties of the soils.

High level humus soils with the plant remains have higher moisture, lower density, large porous. There is the best water treatment and gas exchange in these soils. When we are ploughing down residues it can improve the wasteland or dump rock (of course that does not contain toxic substances such as sulfides), any eroded soil.

It was known long ago that high level humus soils have good physical properties. Obviously, this property has also a role in increasing the yield. But not only that. The chemists have found that humus has buffer to the effects of various chemicals, such as fertilizers. Humus can fix micronutrients than, firstly, saves them from making the soil, and, secondly, in the case of chemical pollution it reduces their toxicity. The humus, like other natural organic matter is a battery of nutrients, especially nitrogen. But this nitrogen is released very slowly: in the expansion of leaves and grass content of nitrogen decreases slower than the carbon content. And the ratio of carbon to nitrogen in humus is less than in the record. Thus, nitrogen humus is inaccessible. However, this feature may be useful: humus prevents losing the nitrogen from the soil, scooping out with water (although in black soils the danger of removal the nutrients from the soil profile is very tiny: not enough water comes in black soils with precipitation).

There is another hypothesis of high fertility of the humus. It is associated with biogeocenose principle formulated by Academician V.N. Sukachev. This is so-called microbiological theory. It is known that the plant is closely related to the life of microorganisms. The microbes live on the leaves of plants, their roots. They fix nitrogen from the air, destroy the organic matter and release these nutrients. Microorganisms in the soil may produce enzymes and thereby increase soil processes. Then maybe high humus soil fertility (mostly black soils) increases - not in the humus, not in the canned nitrogen compounds in it and not even in favorable physical properties, which are created by humus. And, both play an important role in the life of plants and biogeocenosis. But probably the most important part of humus is the creation of a favorable regime and favorable conditions for living organisms. And the microbes help plants, providing them by the nitrogen, and by other nutrients, and possibly by micronutrients. Given fact is that the microorganisms appeared much earlier than plants in the evolution of living matter of the

planet, it is clear that the last had to "coordinate" the existence of microorganisms as the man "agrees" his existing with them.

Not humus nature (it is important, but not in terms of fertility), but rather the quantity and the microbiocenosis - a set of organisms that is created through this humus – that is the cause of fertility the humus, according to the hypothesis. And this, perhaps, is the most important role in creating humus soil fertility.

Thus, as the most humused the black soils have many favorable properties for the plant, which many scientists regard as the ideal properties of the soil. However, we should not forget other soil properties. The practice shows that the plowed soils that have not lost reserves of the humus, are often less fertile due to sputtering, destroying structures, deterioration of physical properties.

There is a limit of humus content for each soil in every climatic conditions. It can't be achieved due to various reasons, such as youth of the soil, erosion, improper use of the territory and more. However, an important element of the fertility (not fully decoded) is hided in humus and the improving of its content inevitably increases crop plants. Humus is a reserve for increasing soil fertility, efficiency. Only the increasing of the soil fertility will decide such important agricultural issues as increasing of the gross harvest of grain, vegetables and more. The saving of high quality humus, buffer adverse effects of soil is one of the major scientific and practical problems.

## REGION AND METHODS OF THE RESEARCH

The study of soil humus had been carried out by The Regional State Engineering Center of soil fertility and quality in the Kirovograd province of Ukraine.

For the determining the qualitative assessment of soil within the agrochemical certification of agricultural lands this center conducted the analytical studies according to the relevant guidelines and recommendations, State Standard and regulations, namely: Methods agrochemical certification of agricultural lands. S.M. Ryzhuka, N.V. Lisovogo and D.M. Bentsarovskoho, 2003, State Standard 4115-2002 – for the detection of moving phosphorus and potassium by a modified method of Chirikov, State Standard 4289:2004 – for determination of organic matter.

## THE RESULTS OF THE STUDIES

The vast majority of soils of the Kirovograd region is black soils, which are lying on an equal plateau watershed and light grade slopes. Comparing with other soils they are more fertile and their accounts for 95% of the arable land of Kirovograd region. They are mostly formed on loess and loess loam under cover of meadow-steppe grass.

The typical black soils are formed in forest-steppe part of Svetlovodskiy, Oleksandrivskiy, Malovyskivskiy, Dobrovelychkivskiy, Novoarkhanhelskiy, Golovanivskiy and Haivorons'kiy and in the north of Znamenskiy, Olshanskiy and

Novoukrainskiy regions under the influence of high depth and hygrophilous grass root system ("General Characteristics soil Kirovograd province", 1976).

The ordinary black soils are formed in the steppe, less moist part of Kirovogradkiy, Kompaniyivskiy, Bobrynetskiy, Dolinskiy, Novgorodskiy, Petrivskiy, Onufri-yivskiy, Ustynivskiy and in the south of Znamenskiy, Olshanskiy and Novoukrainskiy regions under the influence of drought-resistant crops with shallow root system.

The podzolic black soil and regradation soil are also common in forest-steppe part of the region that in agronomic terms are not materially different from the typical black soil and original black soil. Dark gray and gray podzolic soils are less fertile, which occupy about one percent of arable land.

In general we can say that most soil area is soil with a high humus content, these soils constitute about 44.9% (730.8 hectares); 30.7% (500 hectares) are soils with an average content of humus; 17.5 (283 hectares) percent are soils with high humus content; and 7.1% (115 ha) are the soils with low humus content. The average content of humus in the context of individual districts ranges from 2.8 to 5.0% (Hulvanskyy, Sinitsky, Mamchur, Hytruk, 2006).

The soils of northwestern, central and south-eastern parts of the region (4-5%) are better зкщмшвув provided by the organic matter, where is the domination of medium soils typical and ordinary. In black podzolic soils and regradation soil and humus-poor black soils typical and normal in Novoarkhangelskiy, Haivoronskiy Vilshanskiy, Znamenskiy, Oleksandrivskiy and Alexandriyskiy administrative districts humus stocks significantly reduced and do not exceed 4%. The poorest by humus content (2,8-3,0% on average) are lighter in texture soils the Dnieper region (Svitlovodskiy and Onufriyivskiy), where is also the most developed erosion (fig. 1).

Analyzing the movement of humus content in the plow layer soil during the period from 1882 till 2010 we can trace that humus is constantly decreasing. The inventories of organic matter in the last 130 years have decreased on average from 5.5 to 4.1 percent, i.e. 1.4%. The biggest losses of humus soils were in Petrovskiy, Dobrovelyshkivskiy, Olshanskiy and Ustynivskiy regions where they reached 2,2-1,1%.

In 1882, the studies of humus in soils Kirovograd region were made, it ranged from 4.2% to 6.4%, the average content in the same area, was 5.5%. The highest rates were recorded at 6.4% in Dobrovelichkovskiy, Kompaniyivskiy, Malovyskivskiy regions, 6.2% in Dolynskiy area, 6.1% in Bobrynets'kyi, Petrovskiy, Ustynivskiy, areas. The lowest rates were observed in 4.3% Haivorons'kiy region, 4.2% in Onufriyivskiy district (Handbook of agrochemical soil conditions Kirovograd province, 1997).

In 1961, the average humus content ranged about 4.8%. The highest content of humus was in the soils of Dobrovelychkivskiy, Kompaniyivskiy, Malovyskivskiy regions 5.6%. The lowest humus content was in Haivorons'kiy and Onufriyivskiy regions (3.8% and 3.7%).

The great plowed soils, inadequate or unbalanced fertilization contributed to a decreasing of humus content in the soil area. The greatest amount of humus soil

area was lost between 1981 and 1995, approximately 0.4%. But this value is the average. The biggest cost of humus was in soils of Petrovskiy district where the humus content decreased by 1.4%, and in regions such as Olshanskiy, Novomyrhorodskiy, Svitlovodskiy where humus content decreased by 0.9%. The smallest losses were in Ulyanovskiy, Znamenskiy areas 0.1-0.2% (fig. 2).

During 1976-1991 the loss of humus exceeded their income on 0,24-0,38 t / ha in the future (1992-1994.) – 0,41-0,67 t / ha, and in recent years - more than 1 ton per hectare per year. At the same time, soil cover in Ulyanovskiy and Haivorons'kiy regions practically retained reserves of humus at the previous level.

Between 1996 and 2006, the humus content in soils of Kirovograd province decreased by 0.15%, which compared with other periods is small. The humus content in soils of Haivorons'kiy, Golovanovskiy and Novoukrainskiy regions slightly decreased by 0,03-0,37% and Vilshanskiy, Dobrovelichkovskiy and Ulyanovskiy, in contrast, rose by 0.31-0.54% (Hulvanskyy, Sinitsky, Mamchur, Hytruk, 2006).

The increasing of humus content in the soil of some districts, in our opinion, may be due to several factors. Firstly, and foremost, it is mediocre harvests of crops, particularly sugar beet and sunflower, which is characterized by strong passing nutrients. Secondly, in the late 90-ies a large number of fields far from the central estates were hardly processed. As a result, they have grass, so the humification processes prevailed over the processes of dehumification. Thirdly, the majority of small landowners and land users got the areas on eroded lands and refused the agrochemical certification, resulting mainly examined uneroded soils of arable lands and grasslands and pastures with a higher content of humus. By the way the share of the latter in the surveyed states in 2004 increased in Ustynivskiy, Dolynskyy and Svitlovodskiy regions at 1.5-4.0%, which was one of the reasons for the increase of humus content in the average of these areas. In addition, the growing row crops, especially sunflower and maize crops heavily wild grass, and therefore the intensity dehumification minimized. And in a significant reduction in numbers of animals, almost all by-products remained on the field, which also contributed to the accumulation of these years of organic matter in soils surveyed areas.

Overall, the region is observed quite clear downward trend in the humus content in the soil compared to the 80-th years of the twentieth century. By 2005 the agricultural land in Kirovograd province containing 4,22% humus, at 0.18% less than 20 years ago. It should be noted that in terms of areas observed contradictory situation on this indicator. For example, a significant reduction in humus contents was observed in Bobrinetskiy, Vilshanskiy, Holovanivskiy, Dobrovelichkovskiy and Novoukrainskiy areas, from 0.46- to 0.78% in Znamenskiy, Dolynskiy, Oleksandrivskiy and Petrovskiy – an increase of 0.01-0.16% (Helevera, Hulvanskyy, 2008). This situation can’t be explained by some genetic characteristics of soils, because in Znamenskiy district ordinary black soils and deep regradation black soils, in Dolynskiy ordinary black soils, Oleksandrivskiy – podzolic black soils and regradation black soils and Petrovsky - ordinary black soils and ordinary black soils are shallow.

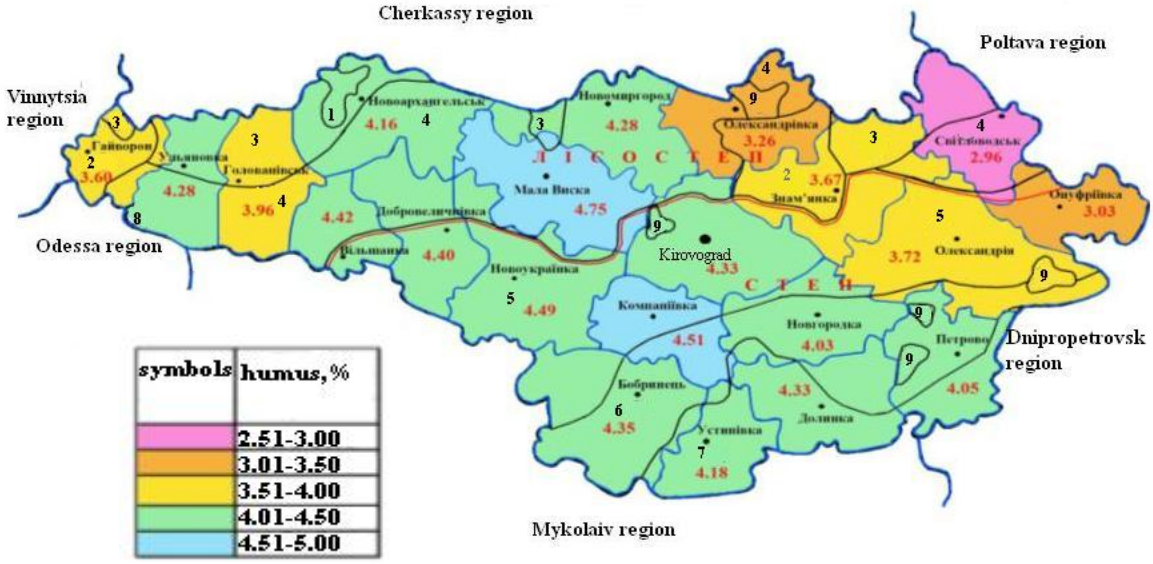


**Fig. 1.** Humus content on Kirovograd province.

**4.10** - average humus on province, %

Name of soils: 1 – gray, dark-gray forest podzolic; 2 – podzolic chernozems; 3 – regradation chernozems; 4 – chernozems typical deep; 5 – ordinary chernozems deep; 6 – ordinary chernozems; 7 – ordinary chernozems skin-deep; 8 – chernozem-solonetz; 9 – meadow chernozem soils.

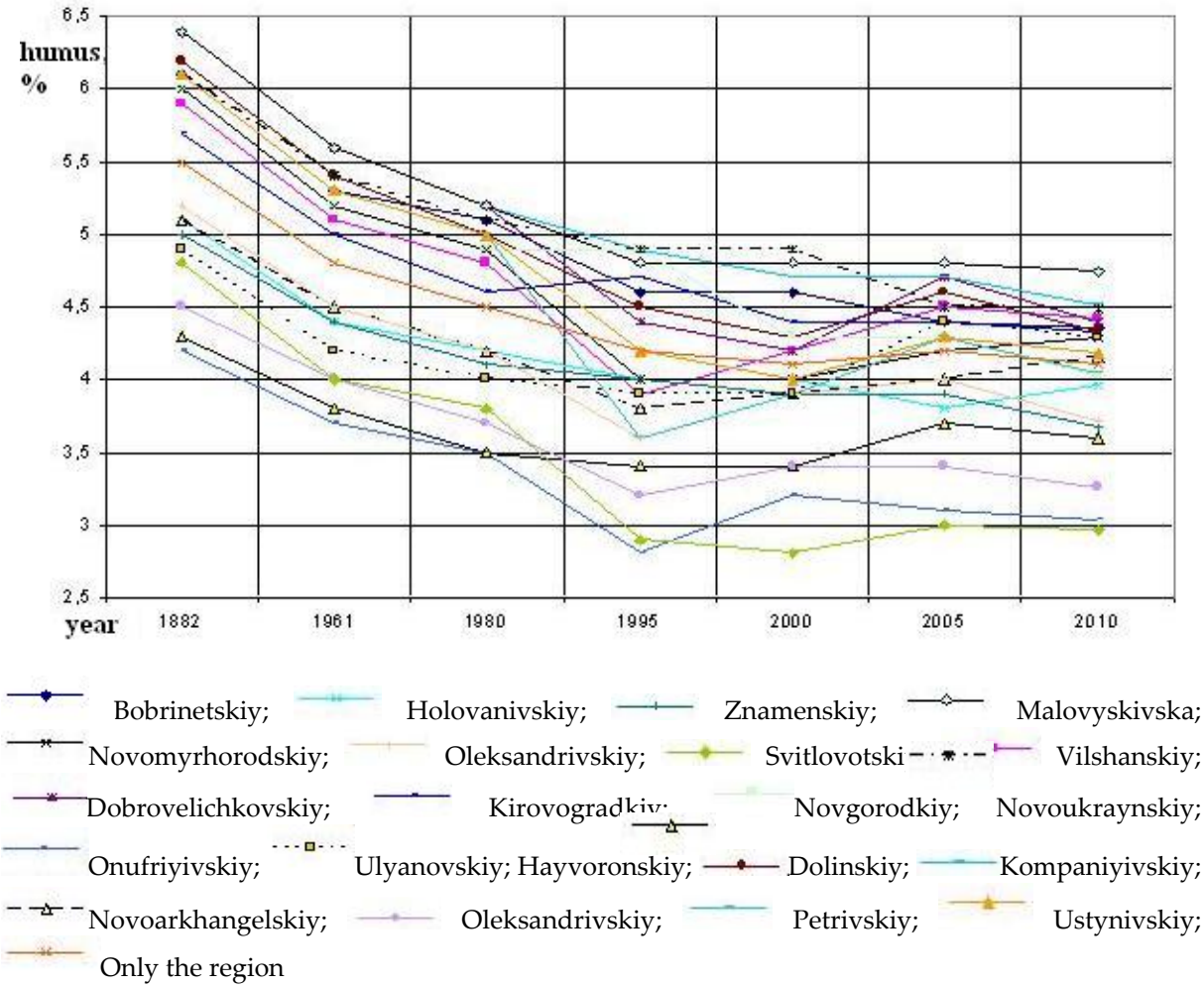


**Fig. 2.** The dynamic of humus content in soils of Kirovograd region by districts.

We can explaine such changes to some extent by the fact that agrocenosis year cycles change of humus content occur in soils. It is mostly found in spring, and the lowest level of it is found during harvest and it is almost fully restored in the fall. It is most clearly expressed by cyclic shallow tillage (Batsula, 1986), which, incidentally, largely shifted by most farms in the region. So as planned economy of Dolinskiy district constantly surveyed in late July – during August when the humus content in the process of self-regulation was at a minimum. During the last round in some households the research was conducted in late autumn, when the humus is almost peaked.

Overall in the region we can see a decrease of areas with very high and high humus content. Thus, if in 2005 they reached about 11.1 and 55.3 percent of the surveyed area, then after 5 years – 7.7 and 50.6 percent. Instead, the number of areas with low, middle and high supply of humus increased.

The results of the researches for the period from 2006 till 2010 showed that as the whole region, and in most areas there was a reduction of the weighted average humus. So the average for the region humus content decreased by 0.12 per cent and in Dobrovelichkovskiy, Znamenskiy, Novgorodskiy and Oleksandrivskiy on 0,26-0,32 percent. At the same time it rose 0.14 and 0.18 percent in Holovanivskiy and Novoarkhangelskiy.

## CONCLUSIONS

For increasing the level of humus we should reduce the proportion of tillage, which is about 80 % from all agricultural soil in Kirovograd region. The level of humus depends now upon the earning to soil organic matter from manure, green manures and byproducts. We have to use scientifically based structure acreage and crop rotation; cultivate more and more perennial grasses and use reforestation of slopes.

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