Acta Agrophysica, 2000, 26, 179-203

REGULARITIES OF PEAT SOILS ANTHROPIC EVOLUTION

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Abstract. Regularities in the transformation of peat structure, organic matter and nitrogen-bearing compounds composition were shown and prognosis of the consequences of the meliorated peat evolution by 2020 are made.

Keywords: peat soils, peat transformation, consequences of degradation.

INTRODUCTION

From the beginning of mires melioration natural peat soil evolution, which is characterised by the processes of peat formation and peat accumulation, is replaced by anthropic evolution characterised by the processes of organic matter mineralization and destruction of peat layer. It is stipulated by the fact that as a result of mire cultivation circulation of substance and energy in peat soils is radically changes. Firstly, in comparison with virgin mires, production of biomass and energy per unit of area increases many times; secondly, due to mineralization and erosion intensification of soil organic matter destruction takes place and the products of peat destruction take out beyond the borders of the drained mires; thirdly, major of the biomass produced is withdrawn from the meliorated fields in the form of harvest. As a result substance and energy accumulative balance of peat soils after mires drainage is substituted by geochemical taking-out prevalence.

Anthropic evolution of the meliorated peat soil proceeds much quicker than natural evolution. Natural evolution of the most ancient peat soils of Poland and Belarus took place during the last post-glacial period - holocene, whereas anthropic evolution lasted no longer than 300 years and most often it was only tens of years. Within such a short period of time a complete destruction of the organic layer of the drained peat soils can be observed. This leads to alterations in their morphological, physical, chemical, biological and other properties. The problem of the quality of new soils formed at different stages of the anthropic evolution of soil layers in the meliorated mires, becomes of interest from the scientific and practical point of view.

The aim of the present article is to find out regularities of the transformation of peat structure, organic matter and composition nitrogen-bearing compounds and classify diversity of the new soils formed as a result of peat layer degradation.

OBJECTS AND INVESTIGATION METHODS

We investigated typical Belarussian meliorated peat soils of the Minsk Experimental Mire Station (MEMS), Polesye Experimental Land-Improvement Mire Station (PELIMS), Ivatsevichy Experimental Land-Improvement Station (IELIS) and production fields of some land-improvement objects. Moreover, we investigated peat soils of the Sarny Experimental Land-Improvement Station (SELIS) which is situated in the Ukrainian Polesye area. In the Minsk Experimental Mire Station we installed two transections for the selection of soil samples which correspond to different stages of peat layer intermixing with the mineral bottoms. By analogy, we got a series of soil samples with a general genesis and similar human utilisation but differing in the content of organic and mineral substance. These soil samples were obtained from other objects.

In the soil samples we defined the content of residue after tempering (RAT), the content of bitumens, humic substances (HS), humic acids (HA), fulvic acids (FA), easily hydrolisible substances (EHS), difficult to hydrolise substances (DHS), and non-hydrolisable residue (NHR) [2]. Soil nitric content was divided into 5 fractions, differing in their resistance to acidic hydrolysis [4]. Succession and conditions for singling out some of the groups of compounds and fractions are given farther.

STAGES OF PEAT SOILS ANTHROPIC EVOLUTION

In bioclimatic conditions of the temperate climate zone, four stages of anthropic peat soil evolution can be distinquished. The first one, a stage of meliorated peat soil, lasts till there remains an isolated peat horizon in the soil profile. This stage is characterised by a systematic reduction of the peat layer depth due to its compression and irretrievable waste of peat.

As a result of systematic reduction of peat resources, this stage of evolution goes step by step according to the following scheme: deep peat soils (peat depth exceeds 2 m); medium deep soils (peat depth - 1-2 m); shallow peat soils (peat depth - 0.5-1 m); peat gleysolic soils (peat depth - 0.3-0.5 m); peaty gleysolic soils (peat depth less than 0.3 m). The general and the main peculiarity of all the steps of evolution at this stage of meliorated peat soils is presence of the clearly isolated peat layers in the soil profiles. Peat layers can consist either of several peat horizons or the plowing layer only.

During every stage of evolution, except the stage of peaty gleysolic soils, destroyed organic matter of the plowing layer is filled up both by the postharvest plant residues and plowing of peat from subsurface horizons. As a result, the depth of the plowing layer is hardly stable during the whole period of peat soil utilization whereas the depth of the subsurface peat layers is gradually reduced. It goes on till the subsurface peat layers are completely destroyed and the plowing layers come into contact with the mineral bed rock.

Further degradation of the organic matter of the plowing layer in the peaty gleysolic soils is accompanied by the gradual plowing of the mineral rock which beds peat and its inclusion in the plowing layer, which results in its gradual enrichment with mineral components and in the reduction of organic matter. As a result of this processes there comes a time when the share of mineral components in the plowing layer begins to excel the share of organic matter. That is why the soil profile looses morphological signs of the peat horizon. Thus ends the stage of the meliorated peat soils as the soil has no more peat horizon and its evolution enters the next stage, i.e., the stage of organic-mineral soils.

The stage of organic-mineral soils begins when the ratio between organic and mineral components of the soil changes so noticeably, as a result of intermixing of peat layer with mineral bed rock, that the plowing layer looses the morphology of the peat horizon. It corresponds to the content of the organic matter in the soil equal to 25-30% and the mineral matter content of 70-75%. With such a correlation between mineral and organic components, the soil is not visually and spectrophotometrically recognised as peat soil. Its peat particles are extremely crumbled and evenly distributed between the mineral particles which previously bedded the peat layer. Under the microscope one can see petty particles of peat and humified fragments of cultivated plants evenly distributed between the particles of mineral rock. Such soils are called anmor in Germany [7], in Poland they are called moorshy soils, when peat is intermixed with sand, and chernozem-like soils when peat is intermixed with loam or loamy sand [15].

The peculiarity of the stage of organic-mineral soil is organic matter resumption only at the expense of the remains of new plants, whereas at the stage of meliorated peat soil, organic matter of the plowing layer is also enriched at the expense of part of the subsurface peat layer. It is one of the principle differences between the organic-mineral stage and the stage of meliorated peat soils.

At the stage of organic-mineral soils, the processes of organic matter mineralization proceeds more intensively in comparison with peat soils due the improvement of the thermal, air and water conditions which favour development of micro-organisms. However, the quantity of organic matter destroyed in one year in the case of organic-mineral soils is smaller than in the meliorated peat soils because the whole of the organic matter is subjected to mineralization which is taking place only in the plowing layer, as the subsurface horizon consists of the mineral rock in 99%.

Morphologically, the plowing layers of organic-mineral soils differ from the plowing layers of mineral soils not only in the high concentration of organic matter but also in the presence of peat particles evenly distributed in the plowing layer. It is the main difference between organic-mineral soils and highly humic mineral ones. Genetically, organic matter of organic-mineral soils is in 90-95% composed of organic matter and only in 5-10% of the humified post-harvest plant residues. Thus, organic-mineral soils are clearly different both from peat and mineral soils.

The stage of mineral residual peat soils begins when peat particles and peat-forming plant fragments are transformed in the plowing layer so drastically that they cannot be observed either under a microscope or visually. The beginning of this stage of evolution corresponds to the organic matter content equal approx. to 14-15%, the depth of peat organic matter transformation is so great that its morphological properties change. Weakly humified organic matter of such soils is represented by the fragments of agronomic cultures and weeds. In other words, the main difference between mineral residual peat soils and organic-mineral ones is the absence of peat-forming plant remains, preserved cellular structure in the organogenic layer.

Total supply of organic matter in a 30-centimeter thick layer of mineral residual peat soils is 120-450 t/ha. Calculations demonstrate that in the period of 100 years of soil cultivation 30-40 t/ha of humus can be formed at the expense of post-harvest plant residue, which constitutes a comparatively small part of the total organic matter supply in such soils. Consequently, despite the loss of peat morphological peculiarities, the bigger part of the organic matter is of mire origin. That is why such soils should be called residual peat soils.

Thus, at the stage of mineral residual peat soils organic matter has two peculiarities: firstly, peat-forming fragments cannot be found in its composition even under a microscope; secondly, despite that bigger part of deeply humified organic matter preserves its peat-mire genesis. The first peculiarity differentiates mineral residual peat soils from organic-mineral ones, whereas the second one distinguishes them from typically mineral soils.

The process of the organic matter reduction continues in the mineral residual peat soils until the quantity of humus becomes equal to the humus quantity characteristic of the typical zonal soils. In order to support humus balance, organic fertilizers are applied to such soil. At this stage of evolution, the share of organic matter formed from post-harvest plant residues and organic fertilizers becomes the main and prevailing one in the soil organic matter.

From this moment the stage the cultivated mineral soil of the zonal type begins. Its properties do not depend any more on the presence of organic matter of the mire origin because by the beginning of this stage, organic matter originating from the mire is practically completely destroyed. Annual renewal of the soil humus with its balance close to zero is characteristic of this stage. This stage is climacteric and can last for an indefinitely long time.

PEAT STRUCTURE CHANGE

After mire drainage, peat-forming process is substituted by the process of cultural soil formation characterized by mineralization, deeper humification and transformation of matter [1,11,13,21], which results in the enrichment of peat soil plowing layers with humus particles in the course of thier exploitation. Peat decomposition degree increases up to 50-70%. This leads to the formation of a new group of soils, the so called earth-like mire soils [7] or according to the classification by Okruszko [13] true moorshes.

Our investigations demonstrated [1] that peat soil transformation mechanism leading to the formation of earth-like layer or moorsh plowing layer is not always observed. As it is shown in Fig. 1, this process is greatly affected by the genetic type of peat and on this basis three groups of meliorated peat soils are formed.

The first group is composed of the soils developing on sedge, moss or sedge-moss kinds of peat. Degree of decomposition in such soils, even if they are old-arable, doesn’t exceed 25-30%. Plowing horizons are characterised by the peat decomposition degree equal to approx. 20-30%. The peat has a fibrous structure.

The second group is composed of the soils developing on woody and reed kinds of peat. Irrespective of the initial peat decomposition degree during the first 5-10 years of culturing, degree of decomposition in the plowing layers of such soils reaches 45-55% and during subsequent years it has a tendency to increase and occasionally reaches the value of 60-70%. Still, the most common degree of decomposition of peat in the plowing horizons of such soils is 45-55%. On these kinds of peat true moorsh and earth-like peat (humus) soils are formed. This group of soils is inclined to drying up, forming disperse structures and to hydrophobisation, which negatively influences agronomic harvests.

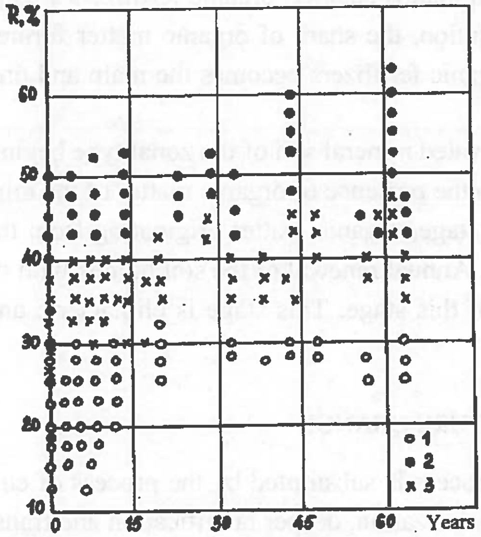

Fig. 1. Relation between degree of decomposition of peat organic matter and duration of agricultural utilisation of peat soils and botanical group of peat: 1-soils on moos and sedge peats; 2-soils on woody and read peats; 3-soils on peats of mixed botanical composition (first and second groups).

The third group is composed of the soils developing on the peats of mixed botanical composition, formed by peat-forming plants characteristic of the first and second groups of soils, for example, woody-sedge, reed-sedge etc. In the cultivated soils the degree of peat decomposition in the plowing layer varies from 25 to 45% but most often it is 35-40%. According to its physical properties, this group of soils is the optimum for the cultivation of agronomic crops.

The author had a possibility to verify the conclusion on the relation between decomposition degree and geobotanic nature of peat in the plowing layer while studying peat soils in Poland and Germany with the cultivation history of 100-250 years. Despite cultivation for such a long period of time, the soils developing on sedge and sedge-moss kinds of peat had decomposition degree in the plowing layer not higher than 25-30%, whereas the soils developing on woody and reed peat had decomposition degree in the plowing layer equal to 40-70%.

It is interesting that other authors [12,14,17] showed that during the period of more than 100 years of agricultural exploitation of the soil developed on lowland moss, peat decomposition degree in the plowing layer, determined by Von Post's method, was rather low and corresponded to 20%.

Peat decomposition degree in the soil plowing layers are low in value and stable in time in the ease of the soils developed on sedge and moss peats create the illusion that peat is not subjected to the processes of decomposition and mineralization in them. It is not so in reality. The low value of decomposition degree in this case only shows that during sedge and moss peat decomposition biochemically stable humic substances are not produced. That is why humus particles do not accumulate in the plowing layer. Still, if moss or sedge peat is mixed with flood-land silt, decomposition degree in the plowing layer can be raised. The peat soils with high content of ash in the flood-lands of the Jakhroma river where sedge-hypnum peat soils have decomposition degree in the plowing layer of approx. 40-50% [21] can serve as a typical example.

Thus, our data confirm the ideas of Skrinnikova [21] and Okruszko [13] about the expediency of the division of peat soils into three groups depending on the manifestation of peat-forming plant transformation into humus. The German classification [8] assumes also division of the meliorated peat soils into 3 groups depending on the degree of peat transformation in the plowing layer.

In Table 1 we compare Russian, Polish and German classifications of the meliorated peat soils. It is obvious that there is no considerable difference between the three groups of soils distinguished in the above countries. In the Polish and German classifications the concept of "degree of decomposition" of peat is replaced by the notion of "murshing" and "vererdung". It is stipulated by the fact that in these countries estimation of peat decomposition degree according to Von Post cannot be applied to the drained peat soils because of peat colloid coagulation due to its dehydration. The methods used in Russia and Belarus permit to estimate peat decomposition degree for any initial humidity level.

Our division of meliorated peat soils into 3 geobotanic groups given in the last column of Table 1 coincides in general with all the classifications mentioned. We are also the first to demonstrate in our data that not all peat soils transform into humic soils (mursh, earth-like) after they have been drained. There are genetic groups of peat soils which in the course of the whole period of their exploitation preserve raw-humic fibrous morphology of the plowing horizon and do not transform into humic soils. It is explained by the peculiarities of peat-forming plants and first of all, by the different content of lignin in the chemical composition, the main source of aromatic structural units in the mire medium for the formation of a biochemically stable aromatic nucleus of humic acids. The higher content of lignin in the peat-forming plants, the more humic acids are produced in peat and vice versa. Woody plants and reed are the richest in lignin, and the content of lignin is the lowest in sedge and especially in moss.

As a rule, in the subsurface layers of peat horizons morphology changes rather insignificantly if ground water levels are permanently kept at the depth of 0.7-1.0 m. In the case of deep lowering of ground water levels, peat in the subsurface horizons of the soils of the second group often over dress and cracks which is accompanied by the formation of a crumble-lumpy structure. Large clefts of 1-3 cm wide appear in the soil profile. They come from the top to the bottom and get narrower as they come closer to normally moistened soil layers. It results in destroying hydraulic bonds between separate layers of the soil profile. Plants begin to feel the

Table 1. Correlation between Russian, Polish and German classifications of drained peat soils

Base morphological peat properties in plowing layer	Russian I.N. Skrynnikova	Polish H. Okruszko	German K. Illner	Groups of peat soils and peat species on which they develop
Weakly decomposed peat (R<25%) with predominance of plant fibres and tissues. Humus particles expressed weekly. Peat structure is fibrous.	Peat soil	Peat moorsh	Fen	1. Raw humic peat soils: moss, sedge, sedge-moss kinds of peat
Middle decomposed peat (R=25-45%), mixture of amorphous humus particles and fragments of plant fibres and tissues. Peat structure is mosaic.	Humus-peat soil	Humus moorsh	Erdfen	2. Humus-fibrous peat soils: woody-moss, woody-sedge, reed-sedge kinds of peat
Highly decomposed peat (R>45%) with predominance of dusty or fine grainy particles. The residues of plants are not observed. Peat structure is dusty and fine grainy.	Humus soil	True moorsh	Mulm	3. Humus peat soils: woody, reed, woody-reed kinds of peat

shortage in moisture. In the case of the first and the second groups of soils formation of clefts and crumble-lumpy streaks was not observed.

In other words, in the course on agricultural usage of peat soils, peat structure transformation depends on its geobotanic nature and the depth of ground waters.

DESTRUCTION RATE OF PEAT LAYER

Three factors determine the rate of peat layer reduction in the meliorated peat soils: their shrinkage, organic matter mineralization and erosion. The rate of these processes depends on the intensity of drainage, mechanical cultivation of the soil, on amount of fertilizers applied, supply of post-harvest plant residues to the soil, duration of cultivation as well as on the botanical composition, degree of decomposition and ash content of peat [1].

Peat waste, due to erosion, in the case of incorrect soil usage can amount to many tens and even hundreds of tons per one hectare in twenty-four hours. For example, in April 1981 the Belarussian Polesye suffered from dust storms which lasted for several days. As a result, root systems of corncobs were bared; large sown areas were destroyed; hundreds of kilometres of canals were filled up with peat blown from the fields. It was noticed that the biggest amount of peat was blown from the fields of intertilled crops. Peat displaced during dust storms amounts to tens of tons per hectare in twenty-four hours. Perennial grasses reduce wind erosion to minimum. At times it can happen during the periods of the meadow rennovation.

Quantitative data on the organic and dry matter waste for various ways of agricultural usage of peat soils is given in Table 2 which represents statistically processed and generalized experimental results of 125 investigations conducted in

Table 2. Statistical parameters of the experimental data of the annual debit of organic matter from peat soils in Belarus in the period 1912-1998, t/ha

Agricultural crops	Number of tests	Deviations	X±mt$_{0.95}$
Average for all crops in Belarus	125	1.7-15.9	6.7±0.6
Perennial grasses:			
all results	36	1.7-11.1	4.4±1.0
under different drainage	34	1.7-8.8	3.7±0.8
under optimum drainage	31	1.7-6.8	3.5±0.6
Cereal crops	12	3.5-10.3	6.0±1.0
Intertilled crops	16	5.5-15.9	9.8±1.6
Crop rotations			
with intertilled crops	87	3.5-15.9	7.7±0.8
without intertilled crops	66	3.5-15.3	7.7±0.8

Belarus during the period from 1913 up to date. Under the conditions of black peat soil cultivation shortage in the annual organic matter balance (in tons per 1 hectare) amounts to: 9.8±1.6 under intertilled crops; 6.0±1.1 under cereals; 3.6±0.7 under perennial grasses. It was experimentally proved [1] that while cultivating perennial grasses for more than 5 years, the rates of mineralization slow down and the shortage in the organic matter balance does not exceed 2 tons per 1 hectare a year. On the peat soils, perennial grasses give maximum yield of the useful product with the minimum waste of the soil organic matter.

FRACTION COMPOSITION OF ORGANIC MATTER

While estimating group composition of organic matter in the meliorated peat soils the following should be taken into account.

Firstly, after peat soils drainage, transformation of their organic matter changes from the conditions of amphibian water-air regime to the regime of permanent aerobiosis of the root layer which favours processes of oxydation and destruction of biochemically unstable components and further humification of organic matter.

Secondly, the remains of crop plants and weed plants, with chemical composition different from that of peat-forming mire plants, get to the organic matter in the plowing layer. As the soil continues to be used agronomically the relative share of humus formed from the residues of cultivated plants in the plowing layer rises, whereas the share of the peat humus goes down.

Thirdly, along exhaustion and shrinking of the peat layer, peat from the subsurface horizons is systematically added to the plowing horizon. It goes on until the subsurface peat layer is completely used up.

The scheme of the organic matter distribution into components given in Fig. 2 is further described [3]. Results of the investigation on the peat soil organic matter group composition in a many-year research are given in Table 3. The above data confirms that the organic matter group composition of the meliorated peat soils is mainly determined by their geobotanic nature and is not significantly changed under the influence of different methods of the agricultural use. Earlier, the same conclusion was drawn by other authors [10,16] for mineral soils.

Even such methods of the intensive anthropic influence as drainage, cultivation of different agronomic crops and mechanical cultivation of peat soils cannot considerably change the organic matter group composition. It can be explained by establishing a dynamic equilibrium between the destruction and renovation of different groups of organic matter due to the systematic inclusion of peat from the lower soil horizons to the plowing layer, humification by post-harvest plant residues

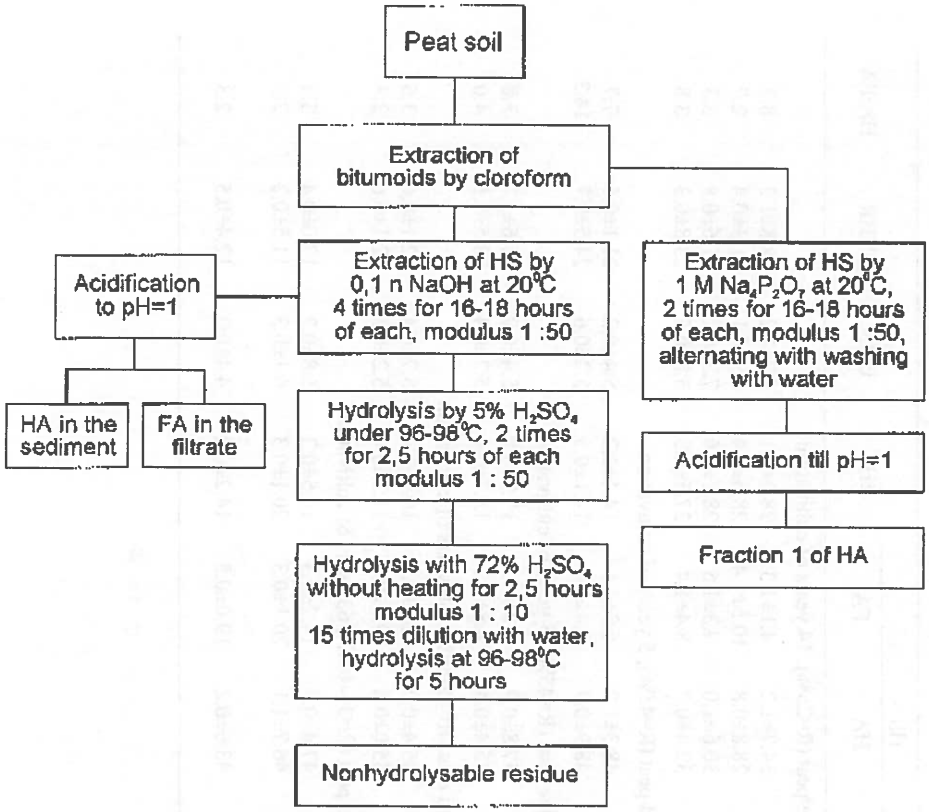

Fig. 2. Scheme of analysis of organic matter fractions.

and microbial synthesis of some groups of substances. These are the main processes that restrain changes in the organic matter group composition and lead to the process of systematic addition of new portions of peat to the plowing layers as a result of its withdrawal from the lower-lying layers.

It is influenced to a lesser extent by the process of organic matter supplementing with post-harvest plant residues. On the basis of the published data concerning MEMS [1,19] and SELIS [5] it is possible to calculate that in the case of initial peat density of approx. 0.15-0.17 t/m^3, the mass of organic matter of the plowing layer formed was about 350-400 t/ha at both of the experimental stations. The average annual organic matter shortage is approx. 6 t/ha. Such a quantity of organic matter could be completely mineralised in 60-70 years. During this period new organic matter entered the plowing layer in the place of the lost organic matter. About 90-95% of this organic matter came from the subsurface layer and only 5-10% came from the post-harvest plant residues. That is why at those stage of peat

T a b l e 3. Influence of different methods of peat soil utilization on the group composition of organic matter in the plowing layer (0-25 cm), %

Method of utilization	Content of OM, % dry matter	Bitimens	HS			EH	DHS	NHR	HA:FA
			total	HA	FA				
PELIMS, soil on sedge peat (R=25%), 14 years of cultivation									
Virgin soil	92.7±0.7	3.4±0.4	38.3±0.2	34.2±1.2	4.1±1.3	28.9±0.1	6.7±1.2	22.8±1.2	8.3
Virgin drained soil	90.7±0.7	2.9±0.5	39.3±0.8	28.8±0.8	10.5±1.4	28.6±0.4	7.9±0.1	21.3±0.4	2.7
Perennial grasses	89.9±0.7	3.0±0.8	39.9±1.9	30.6±1.0	9.3±1.5	28.2±1.0	7.3±0.2	21.6±0.8	3.3
Field crop rotation	75.0±3.5	3.6±0.7	40.8±1.0	32.4±0.7	8.4±1.4	27.5±0.5	5.3±0.5	23.8±0.3	3.8
PELIMS, soil on reed peat (R=45%), 5 years of cultivation									
Virgin soil	88.9±0.2	4.5±0.7	54.6±0.2	48.3±1.2	6.3±1.5	14.4±1.2	5.4±0.2	21.1±0.5	7.7
Field crop rotation	87.6±0.3	4.3±0.2	52.3±1.0	48.9±0.9	3.4±1.4	14.1±0.5	5.2±0.6	24.5±0.7	14.3
IELIS, soil on reed-sedge peat (R=45%), 5 years of cultivation									
Virgin drained soil	82.5±0.1	3.5±0.2	47.6±0.2	37.8±0.9	9.8±1.3	17.9±0.8	5.4±0.9	25.6±1.7	3.8
Field crop rotation	89.1±0.8	3.4±0.3	44.2±1.0	35.4±0.4	8.8±1.2	18.7±0.1	5.2±0.4	28.5±1.5	4.0
MEMS, soil on woody-reed peat (R=45-50%), 60 years of cultivation									
Virgin drained soil	84.7±2.8	33.5±0.3	58.0±0.9	45.4±0.9	12.6±0.5	10.9±0.4	5.7±0.4	22.1±0.6	3.6
Intertilled crop rotation	82.8±0.8	2.1±0.2	64.9±0.8	45.0±0.6	19.9±0.7	11.3±0.4	5.2±0.5	22.1±0.6	2.3
SELIS, soil on reed-sedge peat (R=35-40%), 63 years of cultivation									
Virgin drained soil	88.6±0.7	5.0±0.3	61.6±0.9	47.4±0.7	14.2±0.3	10.5±0.3	5.8±0.2	17.0±0.4	3.3
Perennial grasses last 20 years	82.8±1.1	6.0±0.2	66.8±0.8	46.7±1.1	20.1±0.3	20.1±0.3	6.1±0.3	11.5±0.3	2.3
Intertilled crop rotation last 20 years	83.0±0.4	6.5±0.3	62.6±0.6	43.6±0.2	19.0±0.8	14.2±0.2	4.4±0.2	12.4±0.5	2.3

soil evolution, when it still has a subsurface peat layer, changes in the quantity of the organic matter are not strong enough for any deep qualitative changes.

The fractional composition of humic acids is more sensitive to the cultivation of peat soils. The results given in Table 4 show that in the process of peat soil cultivation, the share of the fraction extracted by sodium pyrophosphate in the humic acid composition goes up, whereas the share of the second fraction additionally extracted with alkali goes down. This characterizes the soils of all the study objects. Even in the cases when total humic acid content is reduced in agricultural usage of peat soils the fractional composition shows the fraction which reduces the content of humic acids. When intertilled crops are grown, humic acids are enriched by the first fraction more intensively than in the case of perennial grasses (Table 4, data for the soils of MEMS and SELIS). It proves quicker rates of destination biochemically unstable fractions under intertilled crops in comparison to meadow vegetation cultivated for a long period of time. Earlier it was experimentally determined on the basis of a four-year balance experiment at MEMS, that average annual rates of mineralization of the pyrophosphate fraction

Table 4. Influence of agricultural use of peat soils on composition of humic acid fractions

Utilization method	HA content % to OM	Fraction 1	Fraction 2
		% to HA	
PELIMS, soil on sedge peat (R=25%), 14 years of cultivation			
Virgin soil	34.2±1.2	24.0±1.2	76.0±1.1
Virgin drained soil	28.8±0.8	28.8±0.8	71.2±1.4
Perennial grasses	30.6±1.0	27.9±1.0	72.1±1.7
Field crop rotation	32.4±0.7	32.1±0.7	67.9±1.2
PELIMS, soil on reed peat (R=45%), 5 years of cultivation			
Virgin soil	48.3±1.2	30.2±1.6	69.8±1.6
Field crop rotation	48.9±0.9	38.1±1.4	61.9±1.4
IELIS, soil on reed-sedge peat (R=40-45%), 46 years of cultivation			
Virgin drained soil	37.8±0.9	32.5±2.4	67.5±2.4
Field crop rotation	35.4±0.4	36.8±3.2	63.2±3.2
MEMS, soil on woody-reed peat (R=45-50%), 60 years of cultivation			
Virgin drained soil	45.4±0.9	46.6±1.8	53.4±1.8
Field crop rotation	45.0±0.6	48.9±1.2	51.1±2.7
SELIS, soil on reed-sedge peat (R=35-40%), 63 years of cultivation			
Virgin drained soil	47.4±0.7	50.8±3.4	49.2±3.4
Perennial grasses last 20 years	46.7±1.1	62.7±3.6	37.3±3.6
Intertilled crop rotation last 20 years	43.6±0.2	67.4±2.5	32.6±2.5

of humic acids constitutes 0.16%, and that of the fraction additionally extracted with alkali is 0.82%, i.e., 5 times higher than by pyrophosphate fraction [20].

Thus, an increase in the share of the pyrophosphate fraction of humic acids in the meliorated peat soils agrees with the peculiarities of its molecular structure [2] and its biochemical stability [20].

However, the share of the pyrophosphate fraction in the humic acids in the plowing layer can increase to a certain limit. The most oxydated and low-molecular part of the fraction is capable of shifting into the solution and moving within the soil profile thanks to the polar functional groups. Sometimes for unknown reasons these water-soluble humic acids concentrate in the form of a humus interlayer streak the plowing layer. For example, in the peat soils of MEMS under the conditions of periodical washing, thickness of the illuvial-humus horizon reaches 11 cm and pyrophosphate fraction clearly dominates in its humic acids composition. In this case, the quantity of humic acids in the MEMS soil subsurface layer was essentially higher than that of the plowing layer. Under the conditions of periodically evaporating water at SELIS, water-soluble part of humic acids does not exceed the limits for the plowing layer. That is why it is gradually enriched with this fraction. Our data confirm the conclusions by Kononova [9], Ponomarova and Plotnikova [18], Orlov and Birukova [16] about the relation between the processes of humus formation and organic matter as a whole and bioclimatic conditions of the country.

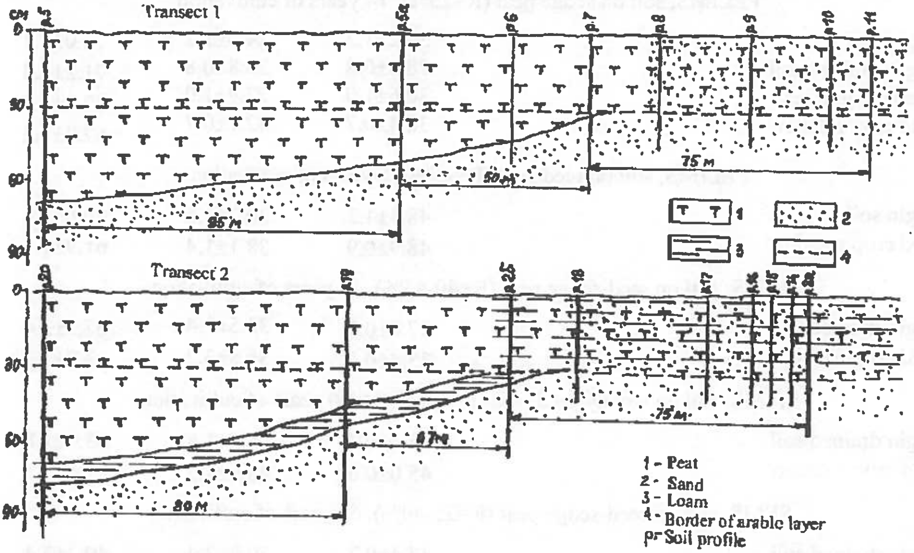

Fig. 3. Transects of soil samples from MEMS.

From Table 4 it can be seen that in the meliorated peat soils formed from different genetic kinds of peat, the composition of humic acids is quite specific. The soils developed on reed, woody and woody-reed kinds of peat are most enriched with the pyrophosphate fraction of humic acids whereas the soils developed on sedge and moss kinds of peat are less rich.

Thus, the fraction-group composition of organic matter in the meliorated peat soils depends on the geobotanic nature of peat, bioclimatic conditions of the country and the cultivated crops.

In order to study the fraction-group composition of organic-mineral and mineral soils formed as a result of peat soil destruction we selected soil samples according to the transects given in Fig. 3. It allowed to obtain soil samples from different stages of evolution with different content of organic matter and mineral parts.

The results given in Table 5 demonstrate that an increase in the residue to 93-95% after tempering and reduction of organic matter content to 5-7% do not lead to any relative changes of the group compsition in comparison to the initial peat soil. For example, at MEMS, the content of bitumoids does not depend on the ratio between organic and mineral components in the soil. The content of humus substances in profiles 1 and 2 (Table 5) fluctuate from 57 to 60% and that of humic acids - from 40 to 45%, although the residue content after tempering in the soil varies, i.e., in profile 1 it is from 30 to 85% and in profile 2 - from 20 to 76%. Similarly the quantity of fulvic acids, easily and hard-hydrolisible substances and non-hydrolisible residue do not depend on the content of organic and mineral components in studied samples. Even after 80 years of soil cultivation at MEMS, organic matter group composition has not changed during anthropic evolution of peat soil to the organic-mineral and further, to mineral ones.

Data obtained in other study objects allow to confirm that a change in the ratio between the organic and the mineral components of peat soils during their agricultural use does not result in the changes of the organic matter group composition.

The question is why under the conditions of such profound changes of the soil profile in the process of agricultural use there are no noticeable changes in the organic matter group composition. Most probably it can be explained by the multiple prevalence of organic matter in the plowing layer, inherited from the initial peat soil over newly formed soil humus after humification by post-harvest plant residues. For example, in the soddy podzolic soils of Belarus, the content of organic matter constitutes 1.5-2.5% and in the soils that we studied it constituted from 5 to 15% in the mineral soils, and from 15 to 30 % in the organic-mineral ones, i.e., soil organic matter formed from peat exceeds organic matter formed from post-harvest plant residues 2-10 times in the case of mineral soils and 6-20 times in the case of organic-mineral ones. Under the condition of such a high prevalence of organic matter of peat origin over the newly formed humus in the process of the agricultural use of the soil, it is impossible to identify differences in the group composition using the existing methods.

It can be assumed that mi-neral soils, newly formed in the place of degraded peat soils, will preserve organic matter group composition analogous to peat soils until the humus content of the plowing layer is reduced to the level of modal zonal soils - approx. 1.5-2.5%. Only in this case prevalence of the newly formed

Table 5. Composition on organic matter groups in peat soils with differentiated content of organic and mineral substances, % to OM

Residue after ignition at 800 °C	Loos on ignition	Bitumoids	HS				EHS	DHS	NHR
			Total	HA	FA	HA:FA			
MEMS, profile 1									
29.7	70.3	1.5	60.6	41.4	18.2	2.3	7.1	12.5	25.4
44.1	55.9	0.9	57.7	40.2	17.5	2.3	8.4	11.2	30.2
86.1	13.9	1.1	60.3	40.2	20.1	2.0	8.4	12.1	25.6
MEMS, profile 2									
20.6	79.4	2.8	58.2	44.1	14.1	3.1	10.1	5.7	23.2
51.6	48.4	3.4	60.8	43.9	16.9	2.6	10.2	6.2	20.4
60.6	39.4	2.0	57.9	43.5	14.4	3.0	11.2	8.0	20.9
64.3	35.7	1.9	59.4	42.2	17.2	2.4	10.8	6.5	21.4
69.2	30.8	1.5	56.5	39.7	16.7	2.4	12.3	7.3	22.4
75.7	24.3	1.5	60.3	45.4	17.9	2.5	9.7	6.5	21.6
95.4	4.6	1.7	59.9	43.7	16.2	2.7	10.3	6.9	21.2
Rakitno, profile 3									
32.1	67.9	4.8	27.4	20.9	6.5	3.2	5.5	2.9	59.4
47.7	42.3	5.3	26.7	18.3	8.4	2.2	4.9	2.5	60.6
61.7	38.3	5.8	28.7	18.3	9.4	2.0	4.3	2.2	59.0
70.6	29.4	6.1	25.7	20.0	5.7	3.5	4.5	2.5	61.2
93.8	6.2	3.0	25.9	19.4	6.5	3.0	4.5	2.8	63.8
Potchepovo, profile 4									
15.3	84.7	2.1	55.3	40.8	14.5	2.8	14.0	7.2	21.4
26.4	73.6	2.5	51.9	43.7	8.2	5.3	13.6	5.9	26.1
67.5	32.5	2.1	55.3	40.4	14.9	2.7	13.9	6.8	21.9
78.0	22.0	2.4	52.1	37.6	15.5	2.4	15.2	6.9	23.4
Sutin, profile 5									
17.5	82.5	5.6	56.6	40.8	15.8	2.6	14.4	8.1	21.1
53.3	46.7	5.2	55.5	42.7	12.8	3.3	12.7	6.2	20.4
82.7	17.3	5.5	57.2	47.7	9.5	5.0	11.9	4.1	21.3

humus from post-harvest plant residues over the organic matter peat origin will begin.

It means that organic matter group composition cannot be taken as a classification criteria for dividing soils into the following groups: peat-formed organic-mineral and mineral, formed as a result of peat soil exhaustion. At these stages of the peat soil evolution, classification criteria should be limited to quantitative estimations of the content of organic and mineral components.

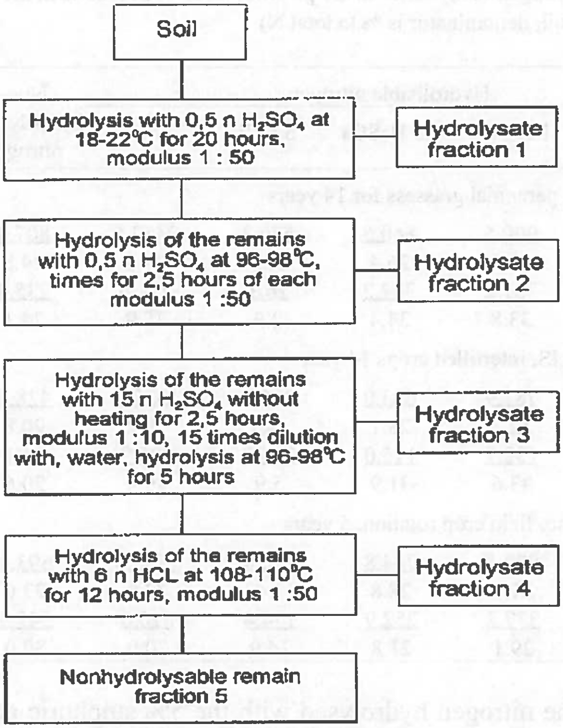

Fig. 4. Scheme of fractions of the soil nitrogen content.

CHANGES IN THE NITROGEN CONTENT

Composition of the peat soil nitrogen content at different stages of anthropic evolution was studied by the method of gradual acidic hydrolysis according to the scheme given in Fig. 4. We started from a well-known statement by Turin (1934) that the efffect produced by acidic hydrolysis on the soil organic matter is anlogous to the effect produced by the ferments of microorganisms. Nitrogen fund of the examined soils is given in Table 6.

The content of the easily-hydrolisible nitrogen in mg per 100 g of soil was essentially reduced when passing from the meliorated peat soils to organic-mineral ones. Thus, in case of perennial grasses cultivated at PELIMS the peat soil with the residue of 22.2% after tempering contains 115.3 mg of easily hydrolisible nitrogen in 100 g, whereas the soil with the residue of 67.3% after tempering contains only 47.9 mg per 100 g. In the case of tilled rotation when passing from the peat soil with the residue of 45.4% after tempering to the mineral one having the residue of 92.0% after tempering reduction of the content of easily hydrolisible nitrogen from 95.8 to 17.0 mg/100 g is observed. But in percentage of the total nitrogen, the share of the easily-hydrolisible nitrogen remains practically unchanged with the reduction of organic matter content and constitutes approx. 3.5-4.9% for the above

Table 6. Fraction composition of nitrogen compounds in the plowing layer of peat soils at the PELIMS and Rakitno (in mg N/100 g of soil, denominator is % to total N)

Left after burning at 800 °C	N_{total} % to dry matter	Hydrolisible nitrogen					Non-hydrolysible nitrogen
		0.5 H_2SO_4	1 H_2SO_4	15 H_2SO_4	6 HCl	total	
		PELIS, perennial grassess for 14 years					
22.2	3.26	115.3	900.5	860.5	576.3	2452.6	807.4
		3.53	27.6	26.4	17.7	75.2	24.8
67.3	0.98	47.9	331.2	337.2	26.3	744.6	235.4
		4.9	33.8	34.4	2.9	75.9	24.1
		PELIS, intertilled crops 14 year					
45.5	2.32	95.8	781.9	653.0	326.5	1837.2	428.8
		4.3	32.8	28.1	14.1	79.2	20.8
92.0	0.36	17.0	132.7	115.0	21.23	285.9	74.1
		4.7	33.6	31.9	5.9	79.4	20.6
		Rakitno, field crop rotation, 5 years					
32.1	2.58	118.9	802.1	744.8	320.8	1986.6	593.4
		4.6	31.1	28.8	12.43	77.0	23.0
70.6	1.16	47.1	337.2	252.9	174.4	810.6	349.4
		4.1	29.1	21.8	14.9	70.0	30.0

mentioned soils. The share of the nitrogen hydrolysed with the 5% sulphuric acid varies within the limits of 27.6-33.8%. The total content of all the fractions of the hydrolisible nitrogen irrespective of the ratio between the organic and the mineral substances in the case of perennial grasses constitutes 75.2-75.9% and in case of intertilled crops - 79.2-79.4%. The share of nonhydrolisible nitrogen also does not depend on the ratio between the mineral and organic components and in the examined soils it is within the limits of 24.1-24.8% of the total nitrogen in the case of perennial grasses and 20.6-20.8% in the case of intertilled crops.281O

Similar results were obtained for the soils of the polder system of "RAKITNO". They agree and confirm the results of the group analysis saying that at those stages of anthropic evolution when the soil organic matter of the peat origin far prevails over the newly formed organic matter from post-harvest plant residues, fractional composition of the nitrogen content does not depend on the organic and mineral substances in the plowing layer. It is determined by the properties of the peat on which the soil is developed.

Thus, fractional composition of the nitrogen content of the organic and mineral soils, formed as a result of peat layer destruction is analogous to the fractional composition of the nitrogen content of the meliorated peat soils from which the organic-mineral and mineral soils have developed. Such similarity of the nitrogen fractional composition can be explained by the prevalence of the organic matter of peat origin over organic matter of the non-mire origin formed from post-harvest plant residues in new soils which is also characteristic of the group composition of organic matter.

Taking into account all that has been stated above we think it is expedient to use the term “residual peaty” in the names of the mineral soils formed as a result of peat layer destriction. This term will reflect their genesis and properties most fully and exactly and will help to distinguish between the mineral soils of the mire origin and those of the zonal type.

DIVERSITY AND CLASSIFICATION OF THE SOILS FORMED AS A RESULT OF PEAT LAYER DESTRUCTION

The most reliable classification criteria for the new soils formed as a result of peat layer destruction are such as soil profile morphology, content of organic and mineral substances and the granulometric composition of the mineral bed on which the initial peat soils were formed.

Basing on the results of our own investigations and literary data [8,13,21] we propose the following classification of the soils formed in the process of anthropic evolution of the meliorated peat soils.

The first group - drained peat soils - includes all the soil varieties with the peat layer with organic matter content not less than 30%. According to the thickness of peat horizon there are distinguish such soils as deep peat soils (peat layer of more than 2 m), medium deep peat soils (peat layer 1-2 m), shallow peat soils (peat layer 0.5-1 m), peat gleysolic soils (peat layer 0.3-0.5 m) and peaty gleysolic soils (peat layer of less than 0.3 m) which correspond to the earlier classifications [8,11,13, 21]. Further subdivision of the soils is made in relation to the peat structure in the plowing layer: raw-humic (fen, peat, moorsh), humus-fibrous (erdfen, humic moorsh) and humic (mulm, true moorsh) as is shown in Table 1. Besides, it is expedient to reflect mechanical composition of the bed rock in the names of shallow peat, peat gleysolic and peaty gleysolic soils as it has a principal importance not only for the formation of water-air and nutritive regime but also for the further interaction of peat and bed rock in the process of peat soil transformation into organic-mineral and mineral soils [15]. Taking these signs into account, the following soil varieties can be singled out in the group of drained peat soils:

- drained peat deep raw-humic soils (fen, peat moorsh);
- drained peat deep humus-fibrous soils (erdfen, humic moorsh);
- drained peat deep humus soils (mulm, true moorsh);
- drained peat medium deep raw-humic soils (fen, peat moorsh);

- drained peat medium deep humus-fibrous soils (erdfen, humic moorsh);
- drained peat medium deep humus soils (mulm, true moorsh);
- drained peat shallow raw-humic soils (fen, peat moorsh) sand bedded;
- drained peat shallow raw-humic soils (fen, peat moorsh) loamy sand bedded;
- drained peat shallow raw-humic soils (fen, peat moorsh) loamy soil and clay bedded;
- drained peat shallow humus-fibrous soils (erdfen, humic moorsh) sand bedded;
- drained peaty shallow humus-fibrous (erdfen, humic moorsh) loamy sand bedded;
- drained peat shallow humus-fibrous soils (erdfen, humic moorsh) loamy ground and clay bedded;
- drained peat shallow humus soils (mulm, true moorsh) sand bedded;
- drained peat shallow humus soils (mulm, true moorsh) loamy sand bedded;
- drained peat shallow humus (mulm, true moorsh) loamy ground and clay bedded;
- drained peat gleysolic raw-humic soils (fen, peat moorsh);
- drained peat gleysolic raw-humic soils (fen, peat moorsh) loamy sand bedded;
- drained peat gleysolic raw-humic soils (fen, peat moorsh) loamy ground and loamy sand bedded;
- drained peat gleysolic humus-fibrous soils (erdfen, humic moorsh) sand bedded;
- drained peat gleysolic humus-fibrous soils (erdfen, humic moorsh) loamy sand bedded;
- drained peat gleysolic humus soils (mulm, true moorsh) sand bedded;
- drained peat gleysolic humus soils (mulm, true moorsh) loamy sand bedded;
- drained peat gleysolic humus soils (mulm, true moorsh) loamy ground and loamy sand bedded;
- drained peaty gleysolic raw-humic soils (fen, peat moorsh) sand bedded;
- drained peaty gleysolic raw-humic soils (fen, peat moorsh) loamy sand bedded;
- drained peaty gleysolic raw-humic soils (fen, peat moorsh) loamy ground and loamy sand bedded;
- drained peaty- gleysolic humus-fibrous soils (erdfen, humic moorsh) sand bedded;
- drained peaty-gleysolic humus-fibrous soils (erdfen, humic moorsh) loamy sand bedded;
- drained peaty-gleysolic humus-fibrous soils (erdfen, humic moorsh) loamy ground and clay bedded;
- drained peaty gleysolic humus soils (mulm, true moorsh) sand bedded;
- drained peaty gleysolic humus soils (mulm, true moorsh) loamy sand bedded;
- drained peaty gleysolic humus soils (mulm, true moorsh) loamy ground and clay bedded.

The second group - organic-mineral soils - includes all the soil varieties that have been formed as a result of peat interaction and mixing with mineral grounds. They contain from 15 to 30% of organic matter in the plowing layer. It is very important with what bed rock, according to granulometric composition, the peat has mixed and what is its structure in the plowing layer. Taking these signs into account the following varieties of organic-mineral soils formed in the process of anthropic evolution can be singled out:

- organic-mineral gleysolic raw-humic soils on sands;
- organic-mineral gleysolic raw-humic soils on loamy sands;
- organic-mineral gleysolic chernozem-like soils on loamy sands;
- organic-mineral gleysolic chernozem-like soils on loamy grounds and clays.

It is obvious that out of 33 kinds of meliorated peat soils not more than 4 kinds of organic-mineral soils can develop. It can be explained by the processes of further deep transformation of peat organic matter after the organic-mineral stage started. All the organic-mineral soils are gleysolic because there are spots of gleyzation in the subsurface layers that were inherited from the initial mire process which took place in the virgin peat soils and was changed after draining.

The third group - mineral residual peat soils - include all the soil varieties which are formed as a result of peat interaction with mineral grounds. They contain not more than 15% of the organic matter:

- residual peaty gleysolic soils on sands;
- residual peaty gleysolic soils on loamy sands;
- residual peaty gleysolic soils on loamy grounds and clays.

It is expedient to subdivide this group of soils into sub-groups according to their organic matter content. For example, sub-groups with high, medium and low content of humus should be singled out. It is not possible at present due to the shortage of the experimental data. Besides, it is not seldom that we deal with illuvial-humic horizons which are common for the soils with hydromorphic genesis.

As the organic matter destruction proceeds, the share of humus of mire genesis is reduced in the plowing layers of the newly-formed mineral soils, whereas the share of humus newly-formed from the post-harvest plant residues goes up. When almost all the humus of the mire origin is changed by the new humus, residual peaty soils are transformed into mineral soils of the zonal type. Quantity, composition and organic matter properties of such soils will be determined by climatic factors and by the properties of the mineral rock on which the soils develop. At this stage, anthropic evolution of peat soils finishes. The territories previously covered with peat soils gain a new structure of the soil cover and the newly-formed mineral soils of the zonal type can exist in the stationary conditions for an indefinitely long. Their fertility will depend on the quantity of the applied organic and mineral fertilizers and on other anthropic influences.

PROGNOSIS FOR THE SOIL COVER EVOLUTION

To prognose of organic matter losses of the meliorated peat soils, it is necessary to know annual amounts of waste per 1 hectare and the area of the drained peat soils. Basing on these data, calculations are made according to the formula:

$$OM + P\,S\,n,$$

where: P - annual loss of organic matter, t/ha; S - area of meliorated peat soils, ha; n - number of years for which the prognosis is made.

Information about organic matter loss of the peat soils of Belarus for different agronomic crops is given in Table 2.

Structure of the areas under various crops in the case of peat soils depends on the depth of the peat layer. If the soil has the depth of the peat layer in the drained conditions exceeding 1 m, crop rotation is recommended with 40% of cereals and 60% of perennial grasses. On the soils with the peat layer depth of less than 1 m, primary cultivation of perennial grasses with tilling cereals is recommended with periods of meadow renovation which corresponds to crop rotation with 80% of perennial grasses and 20% of cereals and other annual crops.

Under these conditions annual loss of organic matter per one hectare of crops rotation area with the peat layer depth not less than 1 m is:

$$3.6 \cdot 0.8 = 7.0 \cdot 0.2 = 4.28 \text{ or approximately } 4.3 \text{ t/ha}.$$

For the soils with the peat layer depth exceeding 1 m it is:

$$3.6 \cdot 0.6 = 7 \cdot 0.4 = 4.96 \text{ or approximately } 5.0 \text{ t/ha}.$$

For the calculation of losses from peat soils dry matter, average ash content of 12% is assumed. Total area of the meliorated peat soils in our republic is 1046.2 thousands of hectares. In the next years this area will not increase.

Soils with the peat layer depth of less than 1 m occupy the area of 686.4 thousands of hectares or 65.6%; those with the peat layer depth of more than 1 m occupy the territory of 359.9 thousands of hectares or 34.4 %. The annual organic matter loss constitutes:

$$4.3 \cdot 686.4 + 5.0 \cdot 359.9 = 4751 \text{ thousands of tons}.$$

Prognostic information on the loss of organic and dry matter of peat with 40% relative humidity is given in Table 7. For the period 2001-2020 about 95 mln. tons of the organic matter, or 108 mln. tons of dry matter, or 180 mln. tons of peat with 40% humidity will be used up in Belarus.

The result of such losses will be reduction of peat layer depth by 6-8 cm. Besides, the annual process of peat layer reduction due to its compression will also

Table 7. Prognosis of the organic and dry matter losses and peat with 40 % humidity content under agricultural use of peat soils in Belarus in the period 2001-2020, thousand tons

Years	Organic matter losses		Dry matter losses with the growing result	Peat with 40% humidity content losses with the groving result
	period	the groving result		
2001-2005	23755	23755	26994	44990
2006-2010	23755	47410	53989	89982
2011-2015	23755	71265	80982	134970
2016-2020	23755	95020	107977	179962

take place. According to some general data [1], the average annual peat layer reduction due tossion is about 1 cm in the plots with peat layer depth not less than 1 m and up to 1.5-2 cm when peat layer depth is more than 1 m. For 20 years peat layer reduction will be from 20 to 40 cm depending on the depth of the peat layer.

As a result of the above mentioned processes noticeable changes in the soil cover structure of the meliorated territories will take place by 2020. Their essence is as follows.

In the territory of about 200 thousands hectares at present occupied by peaty-gleysolic soils, organic layer will mix with bed rock and it will lead to the formation of organic-mineral raw-humic soils sand bedded, instead of peaty gleysolic ones (about 90%) of the territory), and of some small amount of organic-mineral gleysolic chernozem-like soils on loamy sands and loamy soils. The content of organic matter in the plowing layers of such soils will vary from 15 to 30%, whereas their predecessor peaty gleysolic soils have organic matter content from 30 to 90%.

Simultaneously, all the organic-mineral soils formed before 2000 will continue their evolution into the group of mineral residual peaty soils with organic matter content in the plowing layer of less than 15%. According to the last inventory, such soils have already appeared in Belarus on the territory of 224.6 thousands of hectares, 20 years ago it was estimated for about 70 thousands of hectares. The precise area of these soils is not determined at present because there is no special registration for them. The most prospective method of the organic-mineral and residual peaty soils registration is the method of remote diagnostics. It is based on the study of spectral characteristics. But such diagnostics is still under elaboration.

By 2020, all the diversities in the peat soils with peat layer depth of more than 0.3 m will also be markedly transformed due to the reducing of peat layer: deep peat soils will transform into medium deep ones, medium deep peat soils - into shallow ones, shallow peat soils - into peat gleysolic ones and peat gleysolic soils - into peaty gleysolic ones.

The following consequences of the meliorated peat soils evolution can by predicted for the period of the next 20 years.

On those areas where mixing of organogenic layer with bed rock, mainly with sands, will take place there, will be marked changes in the chemical and granulometric composition, as well as in the agrophysical and agrochemical conditions of the plowing layer. The structure of the soil profiles will also change. There will be a sharp increase of the content of mineral components and, first of all, increase in silica. There will be an increase in the soil heat conductivity and temperature conductivity, reduction of moisture reserves, reinforcing of mineralization processes and isolation of organic nitrogen.

Taking into account the fact that the mineral bed of peat soils has a pronounced meso- and micro-relief, then within the field limits there will be an observed increase of the soil cover differentiation and of the soil character, appearance of big amounts of mineral mounds alternating with peat filled small hollows. It will inevitably lead to either the necessity for field disextention or to spatial planning because different micro plots of field will have different levels of ground water. Such an important increase in the soil cover contrast within the limits of the fields will result in a decrease of soil productivity. It will become necessary to apply not only phosphorus and potassium fertilizers but also nitrogenous and organic ones, like in the case of cultivation on soddy podzolic soils.

In the areas where mixing of the peat layer and rock will not happen by 2020, worsening of the soils properties and of the soil cover will be less pronounced and, under the conditions of correct agriculture, productivity of such soils will not be reduced though costs of fertilizers, water regulation reconstruction of the land-improvement systems will rise.

In general, changes in the peat soils which will take place by 2020 will demand additional investments in order to maintain present soil fertility because natural peat soil fertility will gradually deteriorate.

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