

# Impact of the Development the Animal Husbandry on the Condition Organic Matter in Soils

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## Abstract:

Industrialization of agrocomplexes and farms, wide application of fertilizers and pesticides allowed increase in the productivity agrocenoses, but worsened their ecological and safety of received production. Transition to intensive technologies in agriculture showed their active influence not only on agrocenoses, but also on the equilibrium of the entire system. Regulation of the balance of humus in the soil and extended its reproduction can be done in two ways: a) an increase in revenues in the soil organic matter (organic fertilizers, afterreap and root resi-dues), b) the reduction of organic matter mineralization using agricultural methods. Perm Krai is located in the Western Predural'e and defined by the coordinates 56 °06 -61 °39 N and 51 °47 - 59 °03 E. On the Krai territory secreted 6 naturally-farming districts. Earlier, the authors have conducted of agroecological assessment on the humus condition in the soils of the Perm Krai in these districts. The purpose of research is to determine the effectiveness of use of wastes animal husbandry to ensure the sufficient balance of the humus in the soil. Degree of development of territory of the region is different, that is expressed in of agricultural area and stooks cattle. Amount of agricultural lands per 1 head of cattle varies from 4.0 to 8.9 ha, at norm 2 ha. With such development of cattle breeding in the Perm Krai and the use of wastes industry has note very low saturation 1 hectares of agricultural land the organic matter (0.43-1.87 t/ha). Thus, it was found that for increasing saturation 1 hectare of plough land and 1 hectares of agricultural land is necessary to increase the number of animal husbandry, a minimum of 2 times, and increase the use of wastes animal husbandry only cattle will enhance the saturation of one hectare of plough land to 3.0-3.4 t/ha.

## Keywords:

Environmental Sustainability, Soil, Humus, Organic Matter, Animal Husbandry, Agricultural Area

## 1. Introduction

The adopted program of agricultural production development in Russia (till 2020) presupposes its further development with animal husbandry defined as its prioritizing direction. Meanwhile agricultural complexes and farms industrialization, mineral fertilizers and pesticides broad application allowed to increase agroecosystems specific productivity but worsened their environmental friendliness and production safety. The transition to intensive technologies in agriculture showed their active influence not only on agroecosystems but on the whole system balance. In recent years the concept of environmental sustainability of agriculture is becoming increasingly important in the world. Use and quality of agricultural lands play an important role [1-3].

For the last 25-30 years sod-podzolic agrogenic soil of Non-Black Earth Belt lost 20-30% of organic substance. The reasons for this are as follows: fresh organic substance flow into soil decrease; intensification of organic substance mineralization as a result of intense soil treatment; cultivated crop share increase and perennial grass in field crop rotation decrease; a prolonged usage of mineral fertilizers without lime; plough-layer dilution by less humus with considerable increase of plough depth; humus isolation from the field enriched in fine soil in field work; water, wind soil erosion display [4, 5].

Humus stocks in soils of the Perm region are on average 55-80 t/ha. State of the humus content of arable land, and of that in active circulation especially; indicate its rapidly increasing humification. The annual deficit of 898 kg humus /ha. Maintaining this deficiency can lead to irreversible consequences [6-8].

The scientists of Perm Agricultural Research Institute have found out that degradation processes are taking place all over the territory of Perm Krai and if the current situation is not going to be changed, then the storage of nutrient elements in the soil will be completely depleted within 5-7 years, and that this situation will become irreversible [9, 10].

There are two ways to regulate humus balance in soil and to produce it extensively: a) to increase organic substance (fertilizers, crop-root remains) flow into soil; b) to decrease organic substance mineralization by agricultural ways [11-13].

In recent decades, Russia has witnessed an annual reduction and throwing of productive lands [14]. On the territory of Perm Krai there is an annual reduction of the plough land, which is removed out of agricultural use and is gradually becoming a fallow land with different return periods (5, 10, 20 years, etc.). Stopping use of soils results in the loss or modification of some properties to their natural condition. The processes that predominate in virgin soils are restored, sometimes even more intensely, in post-agrogenic soils [15, 16].

Soil quality assessment should be carried out not only by the physical, chemical and physical-chemical parameters, but also the biological activity of the soil is to be taken into account, as it allows to judge the orientation of soil formation processes as well as the condition of soil fertility [17, 18].

The peculiarities of sod-podzolic soils are in their acidity, marked differentiation of soil horizons, relative poverty of nutrient elements and organic matter, feebly marked structure and the presence of the inert podzolic horizon as well as in the flushing type of soil water regime [19, 20].

The research is to determine defining animal husbandry branch wastes usage efficiency to provide non-deficit humus balance in soils.

## 2. Materials and Methods

To determine the effectiveness of the use of waste livestock industry to ensure a balanced balance of humus in the soil is necessary to have an understanding of the geographical location and natural conditions of the Perm region.

Perm Krai is situated in Western Cis-Ural region and defined by 56°06'-61°39' of northern latitude and 51°47'-59°03' eastern longitude (Figure 1). From north to south the territory of the Krai stretches for 600 km, from west to east in the south-ern part of the Krai – for 200 km, in the northern part – for 500 km [21].



**Figure 1.** The objects of the study [22].

According to natural-agricultural zoning Krai territory is totally situated in boreal belt, here three natural-agricultural zones are outlined: middle taiga, south taiga, forest steppe within which natural-agricultural provinces and districts are pointed out. On the Krai territory 6 natural-agricultural areas are outlined and 40 administrative regions (see Table 1).

**Table 1.** Agroclimatic conditions natural-agricultural area in Perm Krai [21]

Natural-agricultural area	Administrative regions	Agroclimatic conditions				
		1*	2	3	4	5
Northern middle taiga	Cherdynsky, Krasnovishersky	1.33	1250	68	489	145
Komi-Permyak Northern-Western Southern taiga forest	Gaynsky, Kosinsky, Kochevsky, Kudymkarsky, Yusvensky, Yurlinsky	1.33	1550	85	469	153
Central-Eastern Southern taiga forest	Aleksandrovsky, Kizelovsky, Chusovskoy, Sivinsky, Dobryansky, Lysva, Ilyinsky, Solikamsk, Perm, Gubakhinsky, Usolye, Gremyachinsky, Gornozavodsky, Krasnokamsk	1.24	1700	93	460	159
Western-Southern-taiga-forest	Kuyedinsky, Vereshchaginsky, Nytvensky, Ochersky, Bolshesosnovsky, Elovsky, Tchaikovsky, Bardymy, Osinsky, Okhansky, Chastinsky	1.15	1750	96	436	156
Southern Southern-forest	Chernushensky, Uinsky, October	1.11	1850	101	423	169
Southern-Eastern forest steppe	Kungur, Suksunsky, Ordinsky, Berezovsky, Kishertsky	1.24	1725	94	473	159

*Note: 1 - moistening coefficient; 2 - the sum of temperatures is above 10 °C; 3 - biological coefficient of productivity; 4 - an amount of precipitation in a year, mm; 5 - the number of days with a temperature above 5 °C*

Agro-climatic conditions show that all areas are poorly provided with heat and fully supplied with moisture. The Northern middle taiga and Komi-Permyak Northern-Western Southern taiga forest areas have low biological productivity, and all the others average.

Perm Krai is distinguished by a variety of natural factors of soil formation, the structure of the soil cover – complexity and contrast, which in turn affects the quality of land used in agriculture. All factors of soil formation have a geographical pattern of changes from North to South, and accordingly, the main properties of the soil are changed. In the Northern regions on top loam and clay formed podzolic soil. In the Central-Eastern Southern taiga forest and southern regions of the region on eluvial-deluvial clays and loams, formed sod-podzolic soils. In the Kungur forest-steppe, podzolized and in a small quantity leached chernozems. The most common are podzolic soils (79.5%), of which the share of sod-podzolic soils account for 39% of the total area of the edge, podzolic – 30.5%. More fertile soil (gray forest and Chernozem podzolized) make up only 4.2%. Marsh and floodplain soils account for 10.7% [21]. In General, the edge is dominated by soils of heavy granulometric composition.

Earlier the authors assessed the humus soil state of Krai in the mentioned above districts [23].

To assess the impact of the livestock industry in the soil humus status of Perm Krai, we used data of Federal State Unitary Enterprise reports GTSAS "Perm" and The National Atlas of Russian soils. Data on average-weighted humus content, land area, cattle stock of administrative districts are calculated by natural-agricultural areas.

### 3. Results and Discussion

It should be noted that the extent of Perm Krai territory development varies (Table 2). The Western part of the Krai concentrates the most agricultural land area (43 % of the Krai agricultural land area); the Northern part concentrates the least agricultural land area only 8 %.

*Table 2. Agricultural land area in natural-agricultural areas, hectare thousand.*

Natural-agricultural area		Kind of land area					
		agricultural land area		plough		hayfield, pasture field	
		2011	2017	2011	2017	2011	2017
1	Northern middle taiga	2.38	1.41	2.20	1.25	0.18	0.16
2	Komi-Permyak Northern-Western Southern taiga forest	56.00	48.88	48.28	44.86	7.72	4.03
3	Central-Eastern Southern taiga forest	159.94	119.34	138.05	113.69	21.89	5.65
4	Western-Southern-taiga-forest	330.72	271.60	288.41	249.09	42.32	22.51
5	Southern Southern-forest	44.85	34.80	37.06	29.74	7.79	5.06
6	Southern-Eastern forest steppe	184.08	161.79	168.72	154.25	15.36	7.54

In 2011 year have the most part of plough on the Southern-Eastern forest steppe agricultural land area (91.7%). Western Southern-taiga-forest agricultural land area (87.2%), Central-Eastern Southern-taiga-forest and Komi-Permyak Northern-Western

Southern-taiga-forest agricultural land areas (86.3%) and Southern Southern-forest agricultural land area (82.6%). In 2017, the distribution of the share of arable land on agricultural land in the in natural-agricultural areas was change: on the Southern-Eastern forest steppe agricultural land area and Central-Eastern Southern-taiga-forest (95.3%). In the Western Southern-taiga-forest and Komi-Permyak Northern-Western Southern-taiga-forest agricultural land areas (91.7%), Northern middle taiga – 88.8%. Change in the share of arable land can be explained, firstly, by an annual decrease in the area of natural-agricultural land in the natural and agricultural areas of the province, and secondly, by transferring them to another category of land.

It should be mentioned that out of all considered natural-agricultural areas only Southern Southern-forest area has less than 50% soil with a low rate of humus content (Table 3).

**Table 3.** Degree of availability of soils of arable grounds with a humus in the Natural-agricultural areas in Perm Krai [23].

Natural-agricultural area	Share of soils with the degree of availability, %						The average content of humus, %
	very low	low	medium	increased	high	very high	
1	48.2	51.0	0.8	–	–	–	1.9
2	34.3	63.8	1.4	0.3	0.1	0.1	2.4
3	26.9	60.8	8.0	2.1	1.4	0.8	2.9
4	32.8	60.3	5.7	0.9	0.2	0.1	2.7
5	1.7	44.2	25.4	11.2	11.4	6.2	4.7
6	2.4	56.1	21.3	9.9	6.3	4.0	4.5
Average	22.6	58.6	10.7	3.9	2.6	1.6	3.2

This area is also marked for the maximum meaning of high humus rate soil (17.6%) and the highest humus content of 4.7%. In Southern-Eastern forest steppe area the considered marks constituted 56.1%, 10.3% and 4.5% correspondingly. In Northern middle taiga area all types soil are characterized by very low (48.2%) and low (51.0%) of humus rate. There are no high humus content types of soil in this area. It can be explained by the fact that initially in these area low-productive podzolic types of soil were formed. Analyzing average-weighted humus content we can conclude that more than 50% of ploughs have a low rate of soil humus, 10.2% – an average rate and only 1.9% – a high rate.

Earlier the authors [23] specified agro-climatic conditions influence on the humus formation process within Perm Krai in natural-agricultural areas and established the equation of humus content dependence on biological production index, moisture index, the number of days with the temperature of 5 degrees C above zero, the annual fall-out number, mm, and the total of temperatures of 10 degrees C above zero. The agro-ecological assessment of Perm Krai soil humus state revealed that humus formation conditions in Perm Krai in middle-and Southern-taiga subzones mostly depends on plant biological productivity and consequently on plant type. In this connection it can be supposed that in agrocenoses changes and reduction of species diversity in addition to out-ploughing and soil fatigue can possibly result in humus formation process worsening. All this leads to humus content reduction in soil. To solve this problem to develop and apply effective arable farming systems with optimal usage of agro-chemical substances and biological factors of soil fertility reproduction is necessary. One of the most important ways of keeping soil fertility and raising agricultural crop rotation productivity consists in organic and mineral fertilizers and their combination usage.

To state whether agricultural areas are enriched in organic fertilizers cattle number and organic fertilizers agricultural areas saturation analysis has been conducted. The Krai territory exploration rate being different, it is reflected in cattle stock, organic fertilizers stock and agricultural areas saturation (Table 4).

*Table 4. Agricultural areas organic fertilizers saturation.*

Natural-agricultural area	Cattle stock (animals)		Organic fertilizers stock, ton thousand		Organic fertilizers saturation plough	
	2011	2017	2011	2017	2011	2017
1	267	105	1.53	0.60	0.70	0.48
2	13690	12112	78.72	69.64	1.17	1.18
3	39371	37908	226.38	217.97	1.97	1.94
4	66205	67731	380.68	389.45	1.29	1.56
5	8233	7858	47.34	45.18	1.29	1.64
6	43924	41851	252.56	240.64	1.32	1.44

It should be noted that in the 2017 year only in the Western-Southern-taiga-forest region there is an increase in the number of cattle heads, in other regions the number of cattle heads decreased compared to 2011. In the Northern middle taiga region, the number of cattle heads decreased by 2.5 times.

In 2011 year the number of agricultural areas per one animal cattle has been stated to vary from 4.0 to 8.9 hectare, in 2017 – 3.1-13.4 t/ha, with the norm of 2 hectare. It means that agricultural areas are used only to 37-49% and in Northern middle taiga area – only to 22%. Under such a level of animal husbandry development in Perm Krai and the branch wastes quantity is marked a very low rate of one hectare of agricultural areas organic substance saturation in 2011 year – 0.65-1.74, in 2017 year – 0.43-1.87.

Having made some calculations we define the necessary quantity of cattle animals in natural-agricultural areas with 2 hectare per one animal and the possible organic fertilizers saturation rate under such conditions (Table 5).

*Table 5. Optimal cattle stock number calculation in natural-agricultural areas.*

Natural-agricultural area	Cattle stock (animals)		Organic fertilizers stock, ton thousand		Organic fertilizers saturation plough	
	2011	2017	2011	2017	2011	2017
1	1189	705	6834	4051	3.11	3.24
2	28002	24442	161009	140539	3.33	3.13
3	79970	57724	459825	331912	3.33	3.02
4	165361	135800	950826	780847	3.30	3.13
5	22426	17400	128947	100050	3.48	3.36
6	92042	80895	529239	465143	3.14	3.02

The calculations have revealed that in 2017 year in Northern middle taiga area animal cattle quantity must be 6.7 times as many than being in stock now. In Southern Southern-forest area this index must be increased by 2.2 times, in Komi-Permyak Northern-Western Southern-taiga-forest area and Western Southern Southern-forest – by 2.0 times, in Southern-Eastern forest steppe area – by 1.9 times and Central-Eastern Southern taiga forest area – by 1.5 times. Under such cattle stock number organic fertilizers plough saturation will constitute 3.02-3.36 hectare thousand, it being 1.6-6.7 times more than under cattle stock in the areas at present.

Scientific establishments have developed the norms of organic fertilizers us-age which will provide non deficit humus balance with obligatory observation of crop

rotation, advanced agricultural equipment, zone shares of mineral fertilizers for different areas, types of soil and other factors. For non-fine soil areas the shares of organic fertilizers on clay-loam soil constitute 10 hectare thousand per year, on sabulous soil – 12-15 hectare thousand per year [24].

At present organic substance plough saturation in natural-agricultural areas amount only to 0.5-1.9 hectare thousand which indicates a low level of animal husbandry organic wastes application. The calculations made to define the optimal cattle stock number don't provide the minimal level of organic fertilizers saturation either and constitute only 3.1-3.4 with the norm of 10-15 hectare thousand. In this connection additional sources of soil filled in with organic substance must be used. Long-term studies on the use of plant residues show that in modern economic conditions, the introduction of perennial grasses in crop rotation and increase their share is an urgent need, since this contributes to an increase in the flow of organic matter into the soil in the form of plant residues, which in turn will allow, against the background of organic and mineral fertilizers, to solve the problem of reproduction of soil humus to its deficit-free balance. Studies conducted at the Perm research Institute of agriculture have shown that in the study of fertilizer application systems in general for crop rotation in the soil comes from 22.03 to 26.08 t/ha of plant residues. As expected, perennial grasses regardless of the system used fertilizer left behind a maximum amount of plant residues 4.87-of 7.08 t/ha, while the potato provided a minimum flow of residue – 1.86-of 2.72 t/ha [25]. Can also the following measures be proposed: the usage of animal husbandry branch wastes from other species of animals and birds; straw ploughback: in organic substance content and the influence on humus reproduction one ton of straw equals 3-4 tons of dropping mass; green fertilizer ploughback (legumes – lupin, seradella, heading; nonleguminous – rape, runch); for example, perennial lupin accumulates up to 20-30 hectare thousand and more of roots out of which up to 2-4 hectare thousands of fresh humus are formed; rational (minimal) soil treatment, anti-erosion soil protection and etc. [21, 26].

#### **4. Conclusions**

Thus, on the basis of the research found that on the basis of the researches carried out it is concluded that for the purpose of one plough hectare and one agricultural area hectare saturation increase in Perm Krai the number of cattle stock need be raised by 2-4 times which will contribute to animal husbandry branch wastes usage going up and this in its turn will make for soil humus content improvement. Thus, the cattle stock number increase will allow to raise the one plough hectare saturation with organic fertilizers with the latter providing conditions of low-productive podzolic soil humus formation process and structuring process close to optimal in Perm Krai. As additional sources of replenishment of organic matter in the soil can be used for alternative organics: waste from the livestock industry from other types of animals and birds, cover crops, post-harvest residues, straw and others.

#### **Conflicts of Interest**

The authors declare that there is no conflict of interest regarding the publication of this article.

#### **References**

- [1] Kiriushin V.I. Greening agriculture and technology policy. Moscow, 2000. 473.

- [2] Abramov N.V.; Semizorov S.A.; Abramov O.N.; Ustinov N.N. and others. Agro-economic Efficiency of Precision Farming. Machinery and Equipment for Rural Area, 2011, 9, 43-45.
- [3] The Department of Agriculture and Foodstuffs of Perm Krai. Analytics. Agro-industrial Complex Development Totals of Perm Krai [Electronic Recourse]. Available online: <http://agro.permkrai.ru/analytics/>
- [4] Zavyalova N.E. Influence of methods of land use on the content of inert and active components in the composition of soil humus of Perm Krai. Perm, 2006, 46-53.
- [5] Samofalova I.A.; Mudrykh N.M.; Karjakina E.V. The apportionment agroecological homogeneous of the sites and their assessment (for example farm). *Soil Science and Agrochemistry*, 2011, 2(20), 94-98.
- [6] Popova S.I.; Kiriakova E.M. Ways to preserve sod-podzolic soil, fertilizer efficiency and productivity of agricultural land of Perm region. Save the fertility of agricultural land as a national asset of the Perm Territory. Perm, 2008, 9-18.
- [7] Samofalova I.A. Ecological problems of animal husbandry and soil fertility. International scientific-practical conference "Modern technologies in veterinary medicine and animal science. The artistic heritage of V.K. Birikh", 3-4 April 2013 Perm.: Publishing House of the Perm State Agricultural Academy, 2013, 38-45.
- [8] Vasbieva M.T., Kosolapova A.I. Changes in fertility parameters and contents of heavy metals of soddy-podzolic soils upon the long-term application of sewage sludge. *Eurasian Soil Science*, 2015, 48(5), 518-523.
- [9] Samofalova I.A.; Kamenskih N. Yu.; Kaigorodov A.T. Modern status of land resources in Perm Krai. Perm Agrarian Bulletin, Perm, 2008, 1, 117-122.
- [10] Popova S.I.; Kosolapova A.I.; Voloshin V.A.; Zavyalova N.E. Optimal land use structure – the basis of modern farming in Perm Krai. Modern aspects of sustainable agricultural landscape design and resource-saving technologies in agricultural industry of North-Eastern region of European part of Russia. Materials of Scientific and Practical Conference dedicated to the 95th Anniversary of Perm Agricultural Research Institute. Perm, 2009, 52-60.
- [11] Buzmakov V.V.; Medvedev A.V.; Trushnikov L.G. Land use and ecology. Vyatka, Moscow, 2003.
- [12] Kizilkaya R.; Akca I.; Ashkin T.; Yilmaz R.; Olekhov V.; Samofalova I.; Mudrykh N. Effect of soil contamination with azadirachtin on dehydrogenase and catalase activity of soil. *Eurasian Journal of Soil Science*, 2012, 1(2), 98-103. Available online: [http://www.fess.org/Eurasian\\_journal\\_of\\_soil\\_science.asp](http://www.fess.org/Eurasian_journal_of_soil_science.asp)
- [13] Yamaltdinova V.; Mudrykh N.; Samofalova I. Effect of fertilizer systems on productivity of field crop rotation and humus content of sod-podzolic soil. Vestnik Bashkir State Agrarian University, 2016, 1(37), 21-26.
- [14] Loiko P.F.; Molchanov P.F. The improvement of legislative regulation on prevention of withdrawal of commercially valuable lands and institutional and management aspects of modern agricultural land use in Russia. Agricultural state and perspectives in use of withdrawn agricultural lands in Russia. Materials of All-Russian Scientific Conference. Moscow, 2008, 126-139.

- [15] Samofalova I.A. Agricultural assessment of anthropogenic ally changed virgin and sod-podzolic soils. Materials of Scientific and Practical Conference “The innovative development of the agricultural industry – scientific support”, dedicated to the 80th Anniversary of Perm State Agricultural Academy. Perm, 2010, 65-69.
- [16] Zav’yalova N.E. Humus and nitrogen in soddy-podzolic soils of different agricultural lands in Perm region. *Eurasian Soil Science*, 2016, 49(11), 1269-1275.
- [17] Valkov V.F.; Kazeev K.Sh.; Kolesnikov S.I. *Soil Sciences*. Publishing Center Mart, Moscow, 2006, 117-120.
- [18] Kizilkaya R.; Dengiz O.; Ozyazitsii M.A.; Askin T.; Mikailsoy F.; Shein E.V. Spatial distribution of heavy metals in the soils of the territory of Bafra (Turkey). *Eurasian Soil Science*, 2011, 12, 1343-1351.
- [19] Kizilkaya R. Samofalova I.; Mudrykh N. and others. Assessing the impact of azadirachtin application to soil on urease activity and its kinetic parameters. *Turkish Journal of Agriculture and Forestry*, 2015, 39(6), 976-983.
- [20] Zavyalova N.E. The agrochemical profile of sod-podzol heavy loam soil in a long stationary experiment. *Scientific journal of the North-East Regional Agricultural Scientific Centre*. 2017, 1(56), 59-65.
- [21] Samofalova I.A.; Mudrykh N.M. Agroecological assessment of organic matter in sod-podzolic soils of Perm Krai. Perm: PPC "Prokrost", 2015, 154.
- [22] Google Planet Earth [Electronic Recourse]. Available online: <https://earth.google.com/web/>
- [23] Samofalova I.A.; Mudrykh N.M. Humus Soil State of Perm Krai. *Collection of Research Papers Sworld*, 2013, 46(3), 84-91.
- [24] Zhukov A.I., Popov P.D. Humus balance regulation in soil. Moscow: Russian Agricultural Industrial Publishing House. 1988.
- [25] Mudrykh N.M., Samofalova I.A., Kosolapova A.I., Yamaltdinova V.R. Effect of Fertilizers on the Productivity of Crop Rotation and on Organic Matter in the Soil. 8<sup>th</sup> International Soil Science Congress on "Land Degradation and Challenges in Sustainable Soil Management". Izmir, 2012, 1, 335-338.
- [26] Mudrykh N.M. Biologization of agriculture as the basis of soil fertility preservation in the Non-chernozem zone. *Bulletin of Altai State Agricultural University*, 2017, 9, 28-34.



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