

The humus balance in light-loam typical chernozem of right-bank forest-steppe of considering non-monetized part of the crop harvest

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The effect of fertilizers and the use of non-tradables part harvest of crops on humus balance in light-loam typical chernozem Right-Bank Forest-steppe. Established that the transition agriculture on short-term crop rotation the basic condition for call-sign balance of humus in the soil may be making use of green manure and straw and leave all the fields of non-tradables harvest.

Key words: *The humus balance, typical chernozem, non-tradables part harvest, crops, manure, straw, green manure, fertilizers*

Management of land resources in agriculture is closely linked with the natural fertility of soils and their spatial structure, on the one hand, and on the other - with the intensity of use of soils under arable land, accompanied by a significant decrease of humus content in the surface layer of soil. [1]. Since the main material for the formation of humus is organic remains of diverse backgrounds, the primary task of enriching humus soil organic matter is considered income in the form residues, growing grasses, manure and other organic fertilizers [2].

Among the measures aimed at ensuring a balanced humus balance, the importance of the use of by-products, as income to the soil organic matter of roots and stubble field crops is a significant addition of humus balance [3].

Of course, plowing almost impossible to achieve initial levels of humus virgin soil conditions have changed since the formation of humus, primarily by reducing the amount of fresh organic matter and increase the degree of aeration. Therefore, you must navigate to the real potential of arable soils humus that provides in this area of high fertility [4, 5].

Research activities were carried out on light loam typical chernozem (Fastiv region) of the Right - Bank Forest – Steppe zone under various agrocaenoses within

the test plot of the Department of Soil Science and Soil Conservation. Stationary (long-term) field experiment had two field crop rotations and two fertilizing schemes. The first crop rotation included perennial grasses, winter wheat, sugar beets, peas, winter wheat, maize (corn) for grain, maize (corn) for silage, winter wheat, sugar beets, and barley with implanted perennial grasses. Fertilizing system included the following variants (per ha of a crop rotation per year): 1) no fertilizers (control), 2) 12 t of farm manure + $N_{55}P_{45}K_{45}$, 3) 3 t of farm manure + 1.2 t of straw + N_{12} + $N_{55}P_{45}K_{45}$, 4) 2.4 t of straw + N_{24} + $N_{55}P_{45}K_{45}$, and 5) 1.2 t of straw + N_{12} + green manure + $N_{55}P_{45}K_{45}$. The second crop rotation included: soybean, winter wheat, corn for grain and barley with the following variants of fertilizing: 1) control (no fertilizers), 2) 1.2 t of straw + N_{12} + $N_{55}P_{45}K_{45}$, 3) 1.2 t of straw + N_{12} + $N_{78}P_{68}K_{68}$, 4) 1.2 t of straw + N_{12} + green manure + $N_{55}P_{45}K_{45}$, 5) 1.2 t of straw + N_{12} + green manure + $N_{78}P_{68}K_{68}$.

In our studies on yield and weight of plant residues, which are the source of the newly formed humus, had a significant influence of organic and mineral fertilizers (Table. 1). The plants are best developed under the influence of fertilizer left over organic residues, resulting in increased intensity of microbiological processes.. High yield positive impact on revenues of fresh organic matter, that there is not a direct correlation between fertility and harvest, but also feedback: high yield through plant remains influences fertility.

Species composition of crops have a significant impact on earnings and humification of plant residues. Yes, only in growing clover there is a positive balance of humus regardless of fertilization.

In the expenditure of the balance sheet of humus include basic parameters of humus loss due to its mineralization in growing different crops. The largest number of mineralized humus in growing sugar beets, peas and corn. Therefore, under these crops there is a deficit balance of humus. Also had a negative balance of humus in growing barley, because this culture leaves a rather small number of root and stubble, and humus mineralized during its growing about 1.23 t / ha.

Table1. The humus balance in the fields crop rotations depending on fertilization options.

Crops rotation	Fertilizing variants	Yield, t / ha	Plant residues with straw, t / ha	The resulting humus from plant residues and organic fertilizers, t / ha	Number of humus, mineralized, t / ha	Humus balance (\pm), t / ha
Perennial grasses	Control	19,0	6,5	1,62	0,6	1,02
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	28,0	9,0	2,26	0,6	1,66
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	26,5	8,6	2,15	0,6	1,55
Winter wheat	Control	3,66	6,1	1,22	1,35	-0,13
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	5,22	7,7	1,55	1,35	0,20
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	4,14	10,6	2,51	1,35	1,16
Sugar beets	Control	34,3	3,1	0,31	1,59	-1,28
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	52,4	4,3	2,75	1,59	1,16
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	59,1	4,7	0,47	1,59	-1,12
Peas	Control	2,91	2,7	0,63	1,50	-0,87
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	3,41	3,0	0,68	1,50	-0,82
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	3,17	2,9	0,66	1,50	-0,84
Winter wheat	Control	3,41	5,9	1,17	1,35	-0,18
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	4,44	6,9	1,38	1,35	0,03
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	4,65	11,1	2,62	1,35	1,27

extension table 1

Maize (corn) for grain	Control	3,80	4,8	0,96	1,56	-0,60
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	6,80	7,9	3,90	1,56	2,34
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	6,90	8,0	1,60	1,56	0,04
Maize (corn) for silage	Control	27,4	4,8	0,82	1,47	-0,65
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	32,1	5,3	0,90	1,47	-0,57
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	32,9	5,4	0,92	1,47	-0,55
Winter wheat	Control	2,54	5,0	0,99	1,35	-0,36
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	3,21	5,7	1,13	1,35	-0,22
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	3,09	9,5	2,30	1,35	0,95
Sugar beets	Control	2,80	2,7	0,27	1,59	-1,32
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	48,3	4,0	2,72	1,59	1,13
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	47,3	3,9	0,39	1,59	-1,20
Barley with p. o.b.	Control	1,70	3,0	0,60	1,23	-0,63
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	2,43	3,6	0,73	1,23	-0,50
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	2,26	3,5	0,70	1,23	-0,53

Comparing variants of fertilization can be seen that the control of the humus balance is negative and is, on average for the year -0.5 t / ha (Table. 2). The use of straw and green manure can increase revenues organic matter to the soil humification on the increase, but the balance remains negative - -0.17 t / ha per year. The small effect of making straw associated with high saturation rotation row crops. Of organic fertilizer in the form of manure has a distinct advantage over other variants of fertilization. Therefore, a positive balance of humus and is 0.44 t / ha per year.

Table2. The humus balance in typical chernozem in 10th-term rotation.

The humus balance per 1 ha of crop rotation area:	Fertilizing variants		
	Control	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅
in rotation	-4,99	4,41	-1,68
the average annual	-0,50	0,44	-0,17

In modern conditions significantly decreased use of traditional organic fertilizers as manure, crop rotation began to dominate short-term rotation with growing economically most profitable crops, changed the relationship between cultivated crops and crops solid seeding. Calculations show that that when growing soybeans and spring barley got scarce humus balance in all variants of fertilization. This is a fairly small number of root and stubble they left after harvest (Table. 3).

The greatest amount of fresh organic matter leaves behind winter wheat (5.11 - 8.51 t / ha) due to growing green manures and making straw. Therefore, in these embodiments, fertilization produced a positive balance of humus (0.35 and 1.06 t / ha).

Only when growing corn because of root and surface remnants achieved a positive balance of humus provided fertilization, but the yield in this case has to be more than 7 t / ha. Thus, due to the aftereffect of straw and green manure humus balance is 0.19 t / ha.

Table 3. The humus balance in short-term rotation depending on options fertilization

Crops rotation	Fertilizing variants	Yield, t / ha	Plant residues with straw, t / ha	The resulting humus from plant residues and organic fertilizers, t / ha	Number of humus, mineralized, t / ha	Humus balance (\pm), t / ha
Soybean	Control	1,55	2,42	0,53	1,5	-0,97
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	3,48	3,49	0,80	1,5	-0,70
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	3,50	3,51	0,82	1,5	-0,68
Winter wheat a	Control	2,94	5,11	1,02	1,35	-0,33
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	5,32	8,45	1,70	1,35	0,35
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	4,72	8,51	2,11	1,35	1,06
Corn for grain	Control	5,39	5,87	1,17	1,56	-0,39
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	7,45	8,05	1,61	1,56	0,05
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	8,11	8,33	1,75	1,56	0,19
Barley	Control	2,57	3,70	0,82	1,23	-0,53
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	4,43	5,31	1,16	1,23	-0,19
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	4,90	5,72	1,21	1,23	-0,02

Considering the impact of different variants of fertilization on soil humus balance we note that the average value loss of humus in the control of higher short-term rotation and make - 0.56 t / ha (Table. 4) than in 10 of the fields (-0.5 m / ha)

crop rotation, and a variant which entered straw as organic fertilizer, on the contrary - losses are lower in the 4th rotation of the fields - -0.12 t / ha, compared with -0.17 t / ha.

Table.4. The humus balance in typical chernozem in short-term rotation.

The humus balance per 1 ha of crop rotation area:	Fertilizing variants		
	Control	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈
in rotation	-2,22	-0,49	0,55
the average annual	-0,56	-0,12	0,14

The use of green manure allows, along with an increase in crop yields, increase the flow of organic matter to the soil, which contributes to a positive balance of humus. Thus, with a combination of green manure and straw balance becomes positive, amounting to 0.14 t / ha.

Thus, in the fields' rotation with a large saturation cultivated crops positive balance of humus can be obtained only with organic fertilizers as manure, and crop short-term rotation enough use of green manures and making straw.

In terms of the intensification of agriculture and the lack of traditional organic fertilizers (manure) one of the measures aimed at creating a positive balance of humus is to keep on the whole-product crop rotation.

Calculating the balance of humus in the 10th fields' rotation subject to the by-products of cultures, we note that the deficit balance of humus preserved only in growing sugar beets, corn silage and barley (Table. 5). When corn silage negative balance was observed in all variants of fertilization and ranged from -0.65 to -0.55 t / ha as by-products in growing this crop on the left. Quite small mass-product falls into the ground and then beet sugar, which is why a positive balance of humus for their cultivation was only a variant of fertilization, which were introduced 12 t / ha manure (1.71 - 1.78 t / ha). The deficit balance of humus obtained after spring barley at the test version fertilization - -0.09 t / ha.

Table5. The humus balance in field crop rotations depending on fertilization options subject to non-tradable parts of the crop.

Crops rotation	Fertilizing variants	Yield, t / ha	Plant residues with straw, t / ha	The resulting humus from plant residues and organic fertilizers, t / ha	Number of humus, mineralized, t / ha	Humus balance (\pm), t / ha
Perennial grasses	Control	19,0	6,5	1,62	0,6	1,02
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	28,0	9,0	2,26	0,6	1,66
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	26,5	8,6	2,15	0,6	1,55
Winter wheat	Control	3,66	11,6	2,33	1,35	0,98
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	5,22	14,5	2,90	1,35	1,55
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	4,14	12,5	2,89	1,35	1,54
Sugar beets	Control	34,3	7,5	0,75	1,59	-0,84
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	52,4	10,5	3,37	1,59	1,78
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	59,1	11,6	1,16	1,59	-0,43
Peas	Control	2,91	6,5	1,50	1,50	0,00
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	3,41	7,4	1,69	1,50	0,19
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	3,17	7,0	1,60	1,50	0,10
Winter wheat	Control	3,41	11,2	2,24	1,35	0,89
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	4,44	13,1	2,61	1,35	1,26
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	4,65	13,4	3,08	1,35	1,73

extension table 5

Maize (corn) for grain	Control	3,80	11,1	2,22	1,56	0,66
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	6,80	17,8	5,88	1,56	4,32
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	6,90	18,0	3,60	1,56	2,04
Maize (corn) for silage	Control	27,4	4,8	0,82	1,47	-0,65
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	32,1	5,3	0,90	1,47	-0,57
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	32,9	5,4	0,92	1,47	-0,55
Winter wheat	Control	2,54	9,6	1,92	1,35	0,57
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	3,21	10,8	2,16	1,35	0,81
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	3,09	10,6	2,51	1,35	1,16
Sugar beets	Control	2,80	6,5	0,65	1,59	-0,94
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	48,3	9,8	3,30	1,59	1,71
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	47,3	9,7	0,97	1,59	-0,62
Barley with p. g.	Control	1,70	5,2	1,08	1,23	-0,15
	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	2,43	6,5	1,36	1,23	0,13
	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅	2,26	6,2	1,30	1,23	0,07

Thus, the introduction of by-products has a positive effect on the balance of humus in the traditional 10th rotation of the fields, increasing its formation on all versions of fertilizing more than three times (tab. 6). The highest value in this case is 1.29 t / ha with manure.

Table6. The humus balance in typical chernozem in 10th rotation of the fields when making a non-tradable part of crops

The humus balance per 1 ha of crop rotation area:	Fertilizing variants		
	Control	12 t of farm manure + N ₅₅ P ₄₅ K ₄₅	1.2 t of straw + N ₁₂ + green manure + N ₅₅ P ₄₅ K ₄₅
in rotation	1,54	12,86	6,60
the average annual	0,15	1,29	0,66

Adding byproducts in growing short-term rotation also significantly increases the rate of balance of humus in the soil (Table. 7). According to our calculations crop by-products ensures the supply of organic matter to the soil in an amount sufficient to create a balanced humus balance on all versions studies. The negative balance was only when growing soybeans in the control (-0.45 t / ha). The highest balance of humus observed in growing corn - 2.1 - 2.26 t / ha due to the large mass of non-tradables harvest.

Thus, the incorporation of by-products can also improve balance and humus in short-term rotation. Thus, controlling it increases to 0.37, compared to 0.15 t / ha control 10 rotations of the fields (tab. 8), and the use of green manure has a higher precedence than manure in the fields rotation 10: 1.44 vs. 1.29 t / ha.

Table7. The humus balance in short-term rotation depending on options fertilization subject to non-tradable parts of the crop

Crops rotation	Fertilizing variants	Yield, t / ha	Plant residues with straw, t / ha	The resulting humus from plant residues and organic fertilizers, t / ha	Number of humus, mineralized, t / ha	Humus balance (\pm), t / ha
Soybean	Control	1,55	4,6	1,05	1,5	-0,45
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	3,48	8,0	1,83	1,5	0,33
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	3,50	8,1	1,87	1,5	0,37
Winter wheat a	Control	2,94	9,8	1,97	1,35	0,62
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	5,32	15,0	3,0	1,35	1,65
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	4,72	15,2	3,43	1,35	2,08
Corn for grain	Control	5,39	14,1	2,83	1,56	1,27
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	7,45	18,3	3,66	1,56	2,10
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	8,11	19,1	3,82	1,56	2,26
Barley	Control	2,57	6,3	1,4	1,23	0,05
	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	4,43	9,6	2,11	1,23	0,76
	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈	4,90	10,3	2,27	1,23	1,04

Table 8. The humus balance in typical chernozem for short-term rotation when making a non-tradable of crop.

The humus balance per 1 ha of crop rotation area:	Fertilizing variants		
	Control	1.2 t of straw + N ₁₂ + N ₇₈ P ₆₈ K ₆₈	1.2 t of straw + N ₁₂ + green manure + N ₇₈ P ₆₈ K ₆₈
in rotation	1,49	4,84	5,75
the average annual	0,37	1,21	1,44

Thus, at the same saturation green manures and organic fertilizers in the form of straw is greatly influenced by the saturation of row crop rotation and duration of their rotation.

Conclusions. The use of organic fertilizers in the form of manure is preferable to making use of green manures and straw in creating a positive balance of humus in typical chernozem, but in the last short-term rotation yield non-deficit balance of humus. Adding non-tradables increases the yield of the receipt of fresh organic matter that provides a positive balance of humus without fertilizer.

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Баланс гумуса в черноземе типичном легкосуглинистом Правобережной Лесостепи с учетом нетоварной части урожая сельскохозяйственных культур

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Исследовано влияние удобрений, а также использования нетоварной части сельскохозяйственных культур на баланс гумуса в черноземе типичном легкосуглинистом Правобережной Лесостепи. Установлено, что при переходе сельского хозяйства на короткоротационные севообороты основным условием для получения положительного баланса гумуса в почве может быть внесение соломы и использование сидератов, а также оставление на полях всей нетоварной части урожая.

***Ключевые слова:** баланс гумуса, чернозем типичный, нетоварная часть урожая, сельскохозяйственные культуры, навоз, солома, сидераты, минеральные удобрения*

БАЛАНС ГУМУСУ В ЧОРНОЗЕМІ ТИПОВОМУ ЛЕГКОСУГЛИНКОВОМУ ПРАВОБЕРЕЖНОГО ЛІСОСТЕПУ З УРАХУВАННЯМ НЕТОВАРНОЇ ЧАСТИНИ ВРОЖАЮ СІЛЬСЬКОГОСПОДАРСЬКИХ КУЛЬТУР

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Досліджено вплив добрив і використання нетоварної частини сільськогосподарських культур на баланс гумусу в чорноземі типовому легкосуглинковому Правобережного Лісостепу. Встановлено, що при переході сільського господарства на короткоротаційні сівозміни основною умовою для отримання позитивного балансу гумусу в ґрунті може бути внесення соломи і використання сидератів та залишення на полях всієї нетоварної частини врожаю.

***Ключові слова:** баланс гумусу, чорнозем типовий, нетоварна частина врожаю, сільськогосподарські культури, гній, солома, сидерати, мінеральні добрива*