



**Calculating the balance of nutrients and heavy metals in crop rotation when using animal by-products. Forecasting changes in soil properties based on balance calculations**

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# Task

Calculate the balance of nitrogen, phosphorus, and potassium for an agroecosystem when using poultry manure, with the following characteristics:

Content of essential plant nutrients in poultry manure

% of dry matter			Moisture, %	% of initial moisture content		
N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O		N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
semiliquid manure						
1.96	0.97	1.12	82.4	0.35	0.17	0.19
solid fraction of semiliquid manure						
2.10	0.99	1.10	56.9	0.90	0.43	0.48

Heavy metal content in poultry manure, mg/kg dry matter

Lead	Cadmium	Copper	Zinc	Arsenic	Nickel
6.5	0.8	18.1	47.8	0.1	12.4

Total formation 63,700 tons, of which:  
42,000 tons: semiliquid manure  
21,700 tons: solid fraction of semiliquid manure

The use of manure is planned on 4,443.3 ha of arable land in crop rotation: complete fallow, winter wheat (3.8 t/ha), sugar beet (55.1 t/ha), barley (4.6 t/ha).



## Nutrient balance calculation

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Nutrient balance is calculated as the difference between the nutrient supply with organic fertilizers and its crop removal

Determination of supply with organic fertilizers

- 1) Determination of the total nitrogen, phosphorus, and potassium entering the agroecosystem with poultry manure, kg (without taking into account storage losses, as the analysis of fertilizers is performed after storage). Performed for each type of manure separately, taking into account the amount of manure formed and the actual concentration of the nutrient in the manure.
- 2) Determination of the mean nutrient supply per hectare of arable land, kg (the accumulation of nutrients in different types of manure is summed up and divided by the area planned for fertilizer use).



# Nutrient balance calculation

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## Determination of removal

1. Determination of removal by each crop, kg (product of yield by yield per removal with 1 ton of product).
2. Determination of mean removal per 1 ha

Balance calculation and forecasting changes in nutrient content:

- For nitrogen, by the supply and removal ratio: forecasting its negative impact on adjacent environments
- For phosphorus and potassium: forecasting changes in their content in the topsoil



## Approximate crop removal of nutrients

Crop	Removal with 1 ton of product, kg		
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Maize (green matter)	4	2	5
Forage root crops	4.9	1.5	6.7
Sugar beet	5.9	1.8	7.5
Maize (kernels)	34	12	37
Winter wheat	35	12	25
Barley	27	11	24
Oat	30	13	29
Pea	66	16	20
Annual grasses (hay)	15	6	20
Perennial grasses (hay)	18	7	20
Irrigated hayfields and pastures (dry matter)	19	6	20



## Calculation of heavy metal supply with poultry manure

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Parameter	Pb	Cd	Cu	Zn	As	Ni
Mean heavy metal content, g/t of manure with initial moisture content	2.00	0.24	5.47	14.39	0.03	3.83
Total metal supply to soil, kg	127.4	15.3	348.4	916.6	1.9	244.0
Supply to soil per 1 ha, g	28.7	3.4	78.4	206.3	0.4	54.9
Shift in soil, mg/kg	0.010	0.001	0.026	0.069	0.000	0.018



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**Thank you!**