



Determining the total area of agricultural land required for environmentally safe utilization of the annual volume of animal by-products

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RD-APK 1.10.15.02-17 “Guidelines on Technological Design of Manure Removal and Preparation Systems”



- Livestock and poultry farms should have sufficient agricultural land area to utilize the annual volume of waste generated, or they should provide for manure treatment to reduce the volume of waste and be able to transport it long distances
- The agricultural land area should be sufficient for environmentally safe use of manure as fertilizer.

Nitrogen, phosphorus, and heavy metal limitations are most often considered when calculating land areas.



Nitrogen-based calculation

Algorithm:

1. Determine annual generation of animal by-products by species
2. Calculate the total amount of nitrogen in the by-products (based on actual nitrogen content in animal products or reference data from RD-APK 1.10.15.02-17)
3. Adjust the amount of nitrogen taking into account storage losses (data on losses from RD-APK 1.10.15.02-17)
4. Calculate the approximate area based on the following requirement: nitrogen application rate not exceeding 200 kg/ha



Nitrogen-based calculation (example)

Assume that the annual manure yield at a full-cycle pig farm (6,000 sows) is as follows:

- Solid fraction with moisture content of 60%: 42,847 t/year
- Liquid fraction with moisture content of 97.7%: 182,672 m³/year

Nutrient content in pig manure

Content in dry matter, %*			Content, kg per ton of manure with estimated moisture content			Content, kg per annual manure volume		
N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Solid fraction								
2.7	2.88	1.25	10.8	11.5	5.0	462,748	492,741	214,235
Liquid fraction								
3.3	0.32	1.25	0.76	0.07	0.29	138,831	12,787	52,975

*RD-APK 1.10.15.02-17



Nitrogen-based calculation (example)

Nitrogen losses during manure storage, treatment, and utilization (RD-APK 1.10.15.02-17)

Type of manure	Total nitrogen losses, %			Fertilizer application method
	when stored for 6 months	during biothermal treatment	during application	
Animal and poultry manure and solid fraction of manure	10	30	5	Plowing
Liquid fraction of animal and poultry manure	15	–	10	Irrigation
Peat-manure composts	10	20	3	Plowing

Notes

1. Organic matter losses during biothermal treatment are 20–30% for animal and poultry manure and solid fraction of manure, and 10% for peat-manure compost.
2. Application losses are specified for plowing on the day of manure spreading. When plowing, losses are 15% after one day, 20% after two days, and 25% after four days.



Nitrogen-based calculation (example)

Considering that 10% of total solid nitrogen and 15% of liquid nitrogen are lost during manure storage, the total amount of nitrogen accumulated in the annual volume of manure at a full-cycle pig farm (6,000 sows), taking into account losses, is 545,479 kg

The approximate area required to apply the annual manure is **2,727 ha** (545,479 kg : 200 kg/ha).

Subsequently, the nitrogen-base application rate and application area should be adjusted taking into account:

- Territory conditions (groundwater protection, terrain, etc.);
- Soil conditions
- Crop rotation and other factors

In the example under consideration, taking into account the challenging topography, the area was increased to **3,650 ha** on the basis of expert assessment



Phosphorus-based calculation (example)

Assume that the annual manure yield at a full-cycle pig farm (6,000 sows) is as follows:

- Solid fraction with moisture content of 60%: 42,847 t/year
- Liquid fraction with moisture content of 97.7%: 182,672 m³/year

Nutrient content in pig manure

Content in dry matter, %*			Content, kg per ton of manure with estimated moisture content			Content, kg per annual manure volume		
N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Solid fraction								
2.7	2.88	1.25	10.8	11.5	5.0	462,748	492,741	214,235
Liquid fraction								
3.3	0.32	1.25	0.76	0.07	0.29	138,831	12,787	52,975

*RD-APK 1.10.15.02-17



Phosphorus-based calculation (example)

Input with organic waste, with planned application area of 3,650 ha: 138.5 kg/ha
(505,528 kg : 3,650 ha)

Consumption, taking into account the crops and their percentage in the crop rotation: 45 kg

Balance: +208%

The annual input of the nutrient in excess of crop removal will be around 94 kg, increasing the mobile phosphate content in the soil by about 8–10 mg/kg.

Given that the weighted average content of mobile phosphorus in the soil at the time of calculations was 190 mg/kg, the phosphorus balance can be positive in the first years, making up to 208%, before reaching a very high phosphate content (above 250 mg/kg).

Considering the basic standard cost, this would require 6–8 years.

When using approximately 55% of solid fraction of manure, the phosphorus balance in soils of the adjacent territory will be zero

Forecasted changes in heavy metal (HM) content in soil when using animal by-products



Parameters	Pb	Cd	Zn	Ni
HM content in manure, mg/kg dry matter	28	0.22	104	24
HM input with manure, g/ha*	164	1.3	610	141
Increase in HM content in soil, mg/kg**	0.055	0.0004	0.203	0.047
Number of years in which the HM content in soil will increase by 1 mg/kg	18	2,500	4.9	21
Background HM content in soil, mg/kg	8.7	0.61	26.6	22.8
Number of years in which the HM content in soil will reach the approximate permissible concentration	1,023	975	363	366

*Based on the application rate of 21,424 tons of dry matter per 3,650 ha

**Based on the average topsoil weight of 300,000 kg

The simplified calculation does not take into account crop removal of metals, losses of metals with surface runoff, and other cost items. Accordingly, the actual accumulation of toxic agents in the soil will be significantly slower than predicted.



Calculation of the maximum single dose of animal by-products

The maximum single application rate of organic fertilizer is determined by the nitrogen content: in general, it should not exceed 200 kg of nitrogen per 1 ha (this applies to semiliquid manure).

This application rate can be adjusted depending on soil and climatic conditions of the territory, as well as the expected crop removal of the nutrient.

A strict limitation of the application rate in accordance with RD-APK 1.10.15.02-17 “Guidelines on Technological Design of Manure Removal and Preparation Systems” only applies to manure tank residue, manure centrate, and excessive activated sludge, which should be applied before tillage once in four years; the annual average load should be 200 m³/ha.



Thank you!