

SOIL ORGANIC MATTER MONITORING AND MANAGEMENT IN BELARUS

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Goal and tasks of research

- **Soil fertility status is commonly evaluated every 4 years in Belarus – SOM, pH value, P₂O₅, K₂O and micronutrients. Sustainable optimum SOM (humus) management has priority importance to prevent soil fertility degradation or pollution.**
- **The research aims to quantify the dynamics of SOM content and humus balance in arable land in relation to soil properties and to the main management factors at farm and district level .**

Research tasks:

- **Dynamics of SOM content in arable land for period 1996-2008.**
- **Ecological SOM function on contaminated land after Chernobyl accident**
- **To quantify the relation of management factors to humus reproduction.**
- **To develop multiple regression model for prognosis of SOM balance at farm and district level.**

Materials and methods

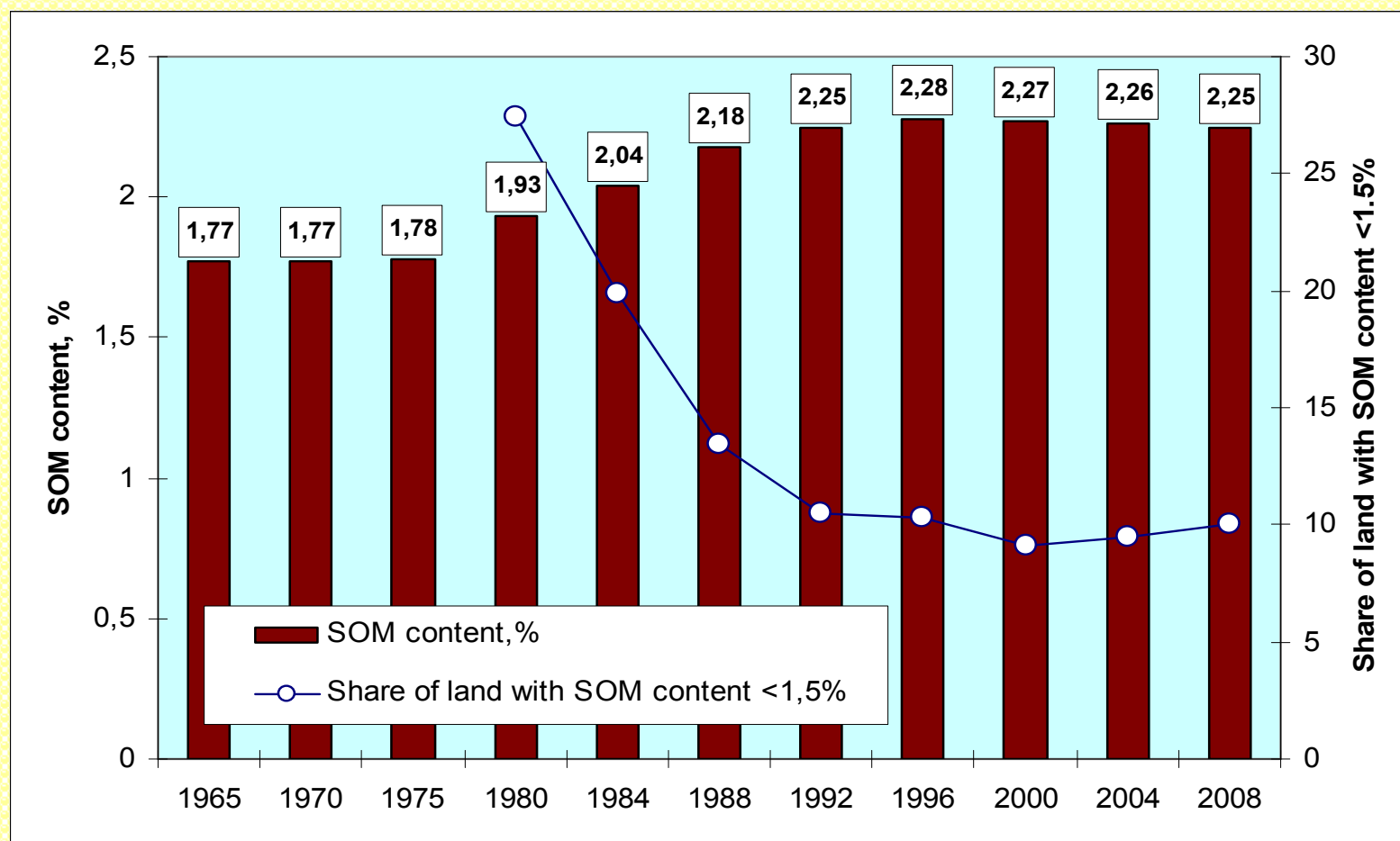
- The dynamics of mean Soil organic matter (SOM) content and balance in arable soils of Belarus, Soil texture, Share of drained soils (%) according to data of State Agrochemical Soil Survey had been studied:
 - on country (National) level over the period 1965 - 2008;
 - for 118 districts of Belarus over the period 1996 - 2008;
 - for 160 farms of Gomel region over the period 1996 - 2008;
- The data for factors related to dynamics of SOM content and balance in arable land for studied periods had been collected from the State Statistics Committee and from Annual Farm Reports:
 - annual farmyard manure (FYM) and fertilizer application rates, $t\ ha^{-1}$, $kg\ ha^{-1}$;
 - cropping pattern (share of Perennial grass and ratio Perennial grasses; Row crops) on arable land;
 - productivity of arable land (cereal units $t\ ha^{-1}$);
- Long-term field experiment with FYM and fertilizer rates on Luvisol loamy sand soil contaminated with ^{137}Cs and ^{90}Sr .

Land of Belarus

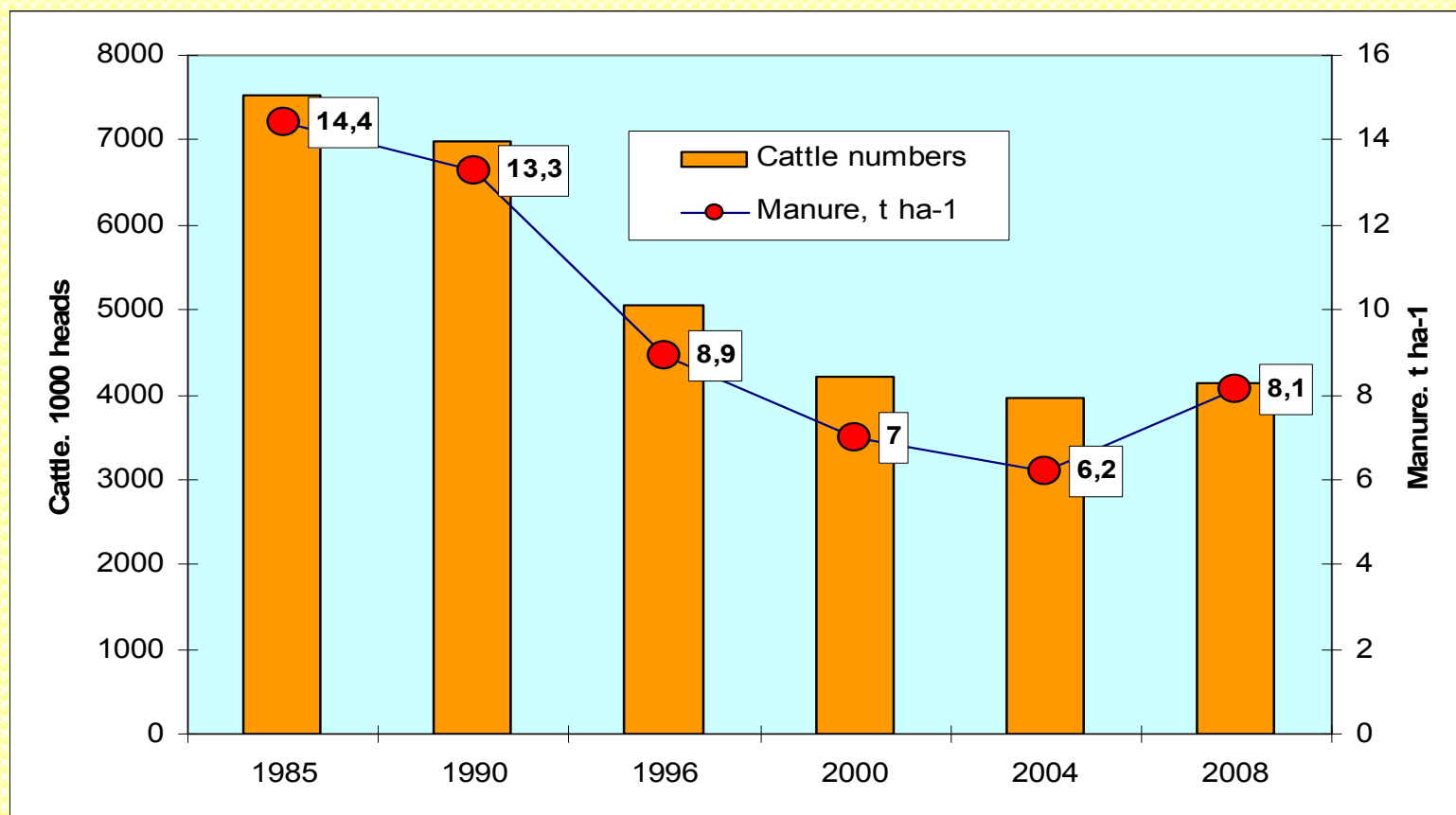
	Area		Drained 10 ³ ha
	10 ³ ha	%	
Total	20.7	100.0	3.4
Agriculture	8.9	43.0	2.9
Arable	5.5	26.6	1.3
Orchards	0.12	0.60	
Grassland	3.3	15.9	1.6
Forest	8.5	40.2	0.3

Owners:	%
State & cooperative farms	81.2
Personal plots	15.3
Private farmers	0.6

Dynamics of mean SOM content in arable land of Belarus (1965-2008)



Dynamics of cattle numbers and annual rates of manure application on arable land of Belarus

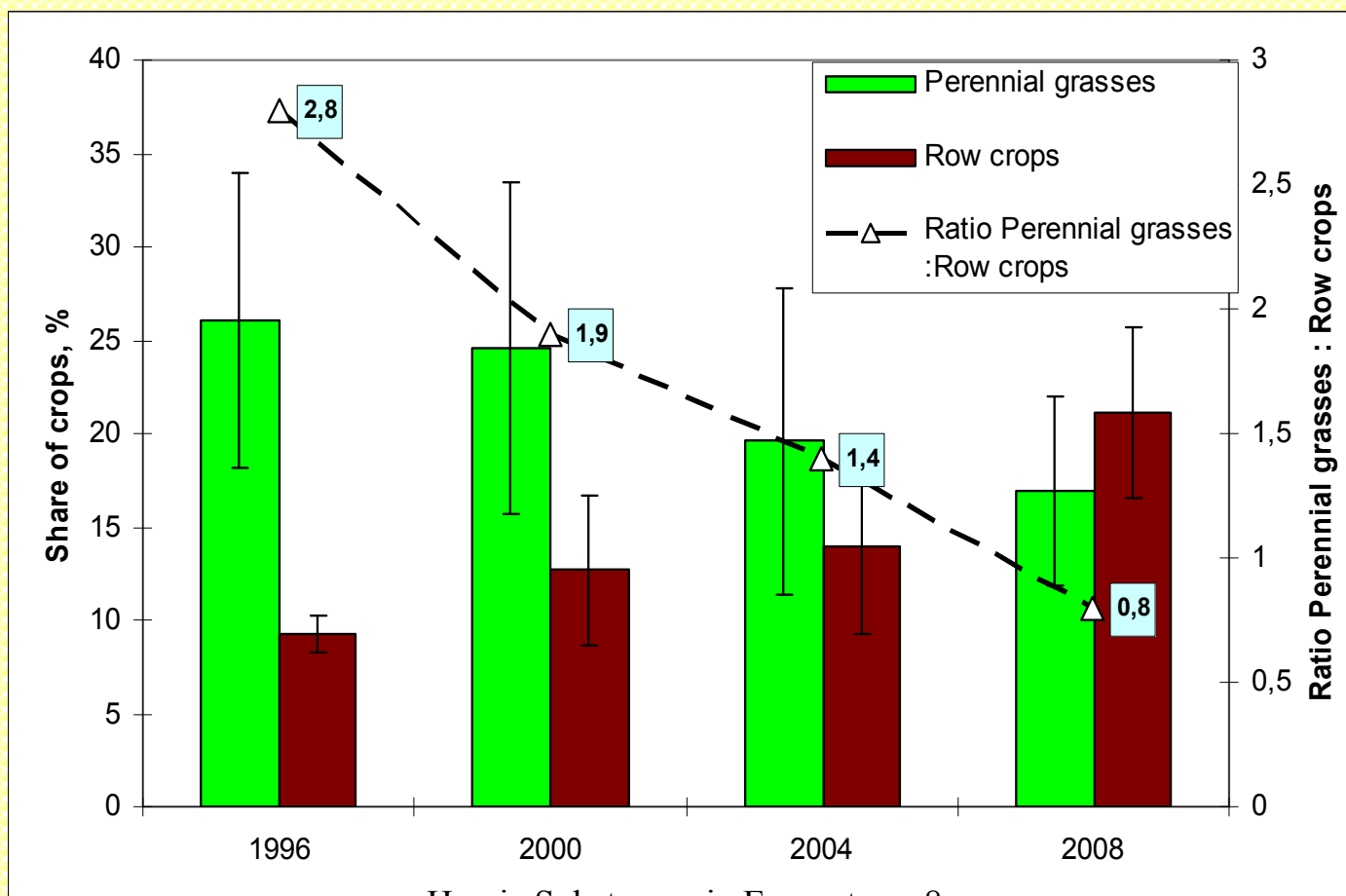


Cattle stock head / 100 ha : 1985 - 81, 2008 - 46.

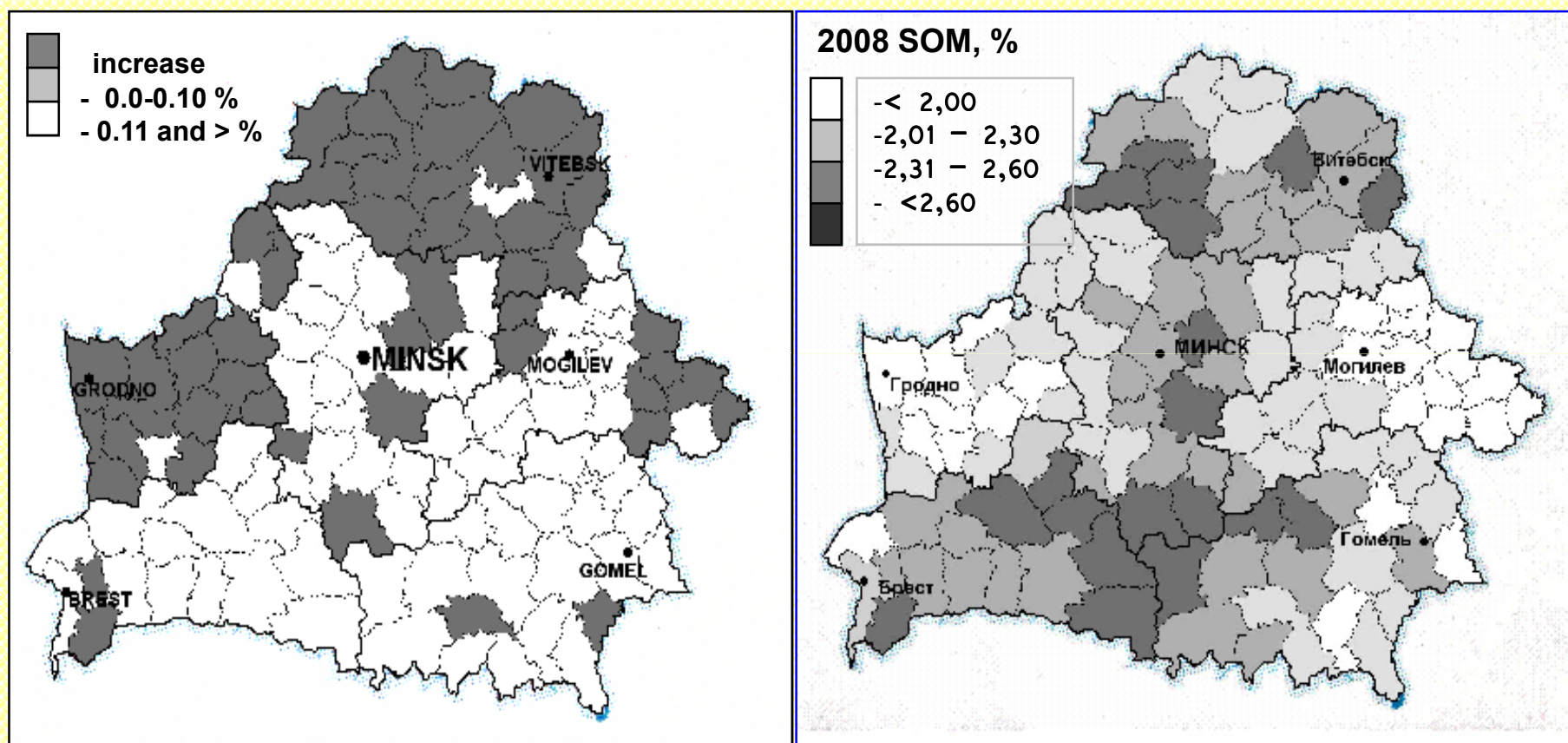
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Šoporňa 13.-17.9.2009 Slovakia

Dynamics of cropping pattern on arable land in Belarus for period of 1996-2008



Dynamics of SOM content in arable land of Belarus (1996-2008)

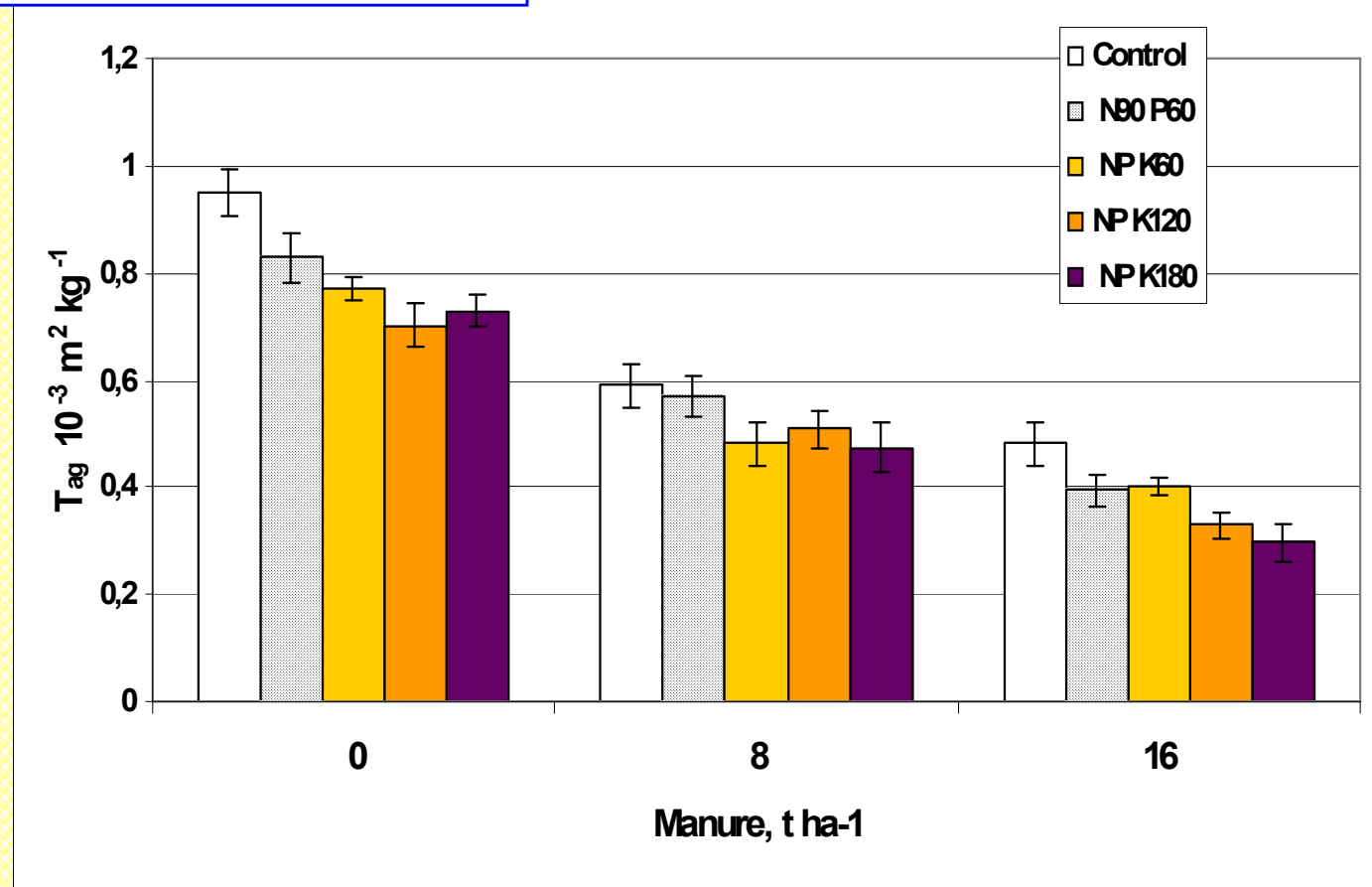


The soil tests indicated a fall in SOM content on 60 % of arable land.

T_{ag} of ^{90}Sr transfer from soil to spring wheat grain in relation to manure and K-fertilizer rates

RF due to manure rates 2.0-2.4
RF due to fertilizers 1.3-1.6

^{90}Sr , S. wheat



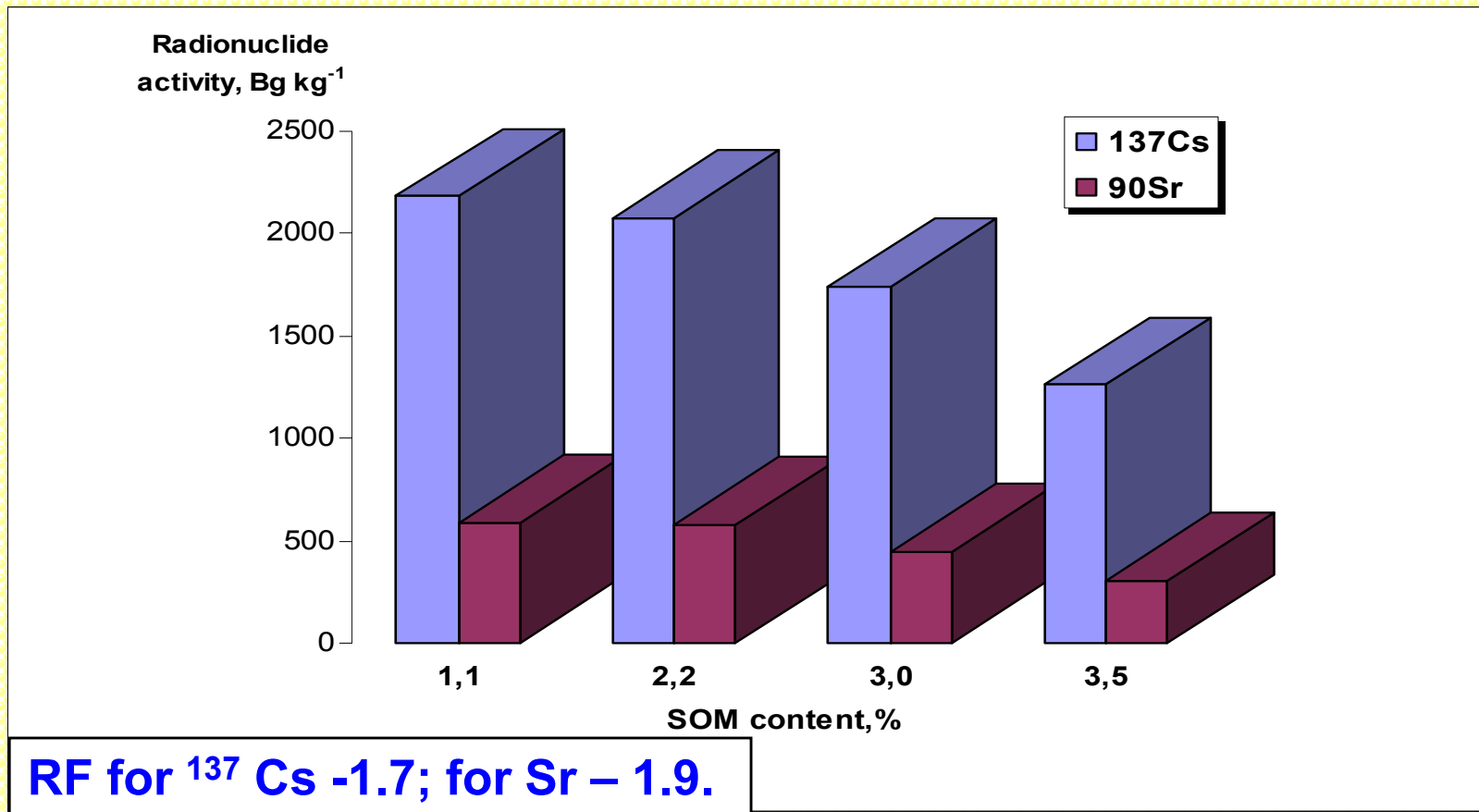
Radiological efficiency of FYM application in long-term experiment on Luvisol loamy sand soil

Fertilization	Crop Yield, cereal units t ha ⁻¹		T _{ag} of ¹³⁷ Cs transfer from soil to crops, %		T _{ag} of ⁹⁰ Sr transfer from soil to crops, %	
	1999-2003	2004-2007	1999-2003	2004-2007	1999-2003	2004-2007
Control	2.1	2.5	100	100	100	100
FYM 8 t ha ⁻¹	3.0	3.1	69	82	85	74
FYM 16 t ha ⁻¹	4.0	4.0	61	71	67	67
N60P90K90	3.7	4.3	60	70	85	78
NPK +FYM 8 t ha ⁻¹	4.9	5.0	50	58	67	65
NPK +FYM 16 t ha ⁻¹	5.86	5.90	43	47	47	52

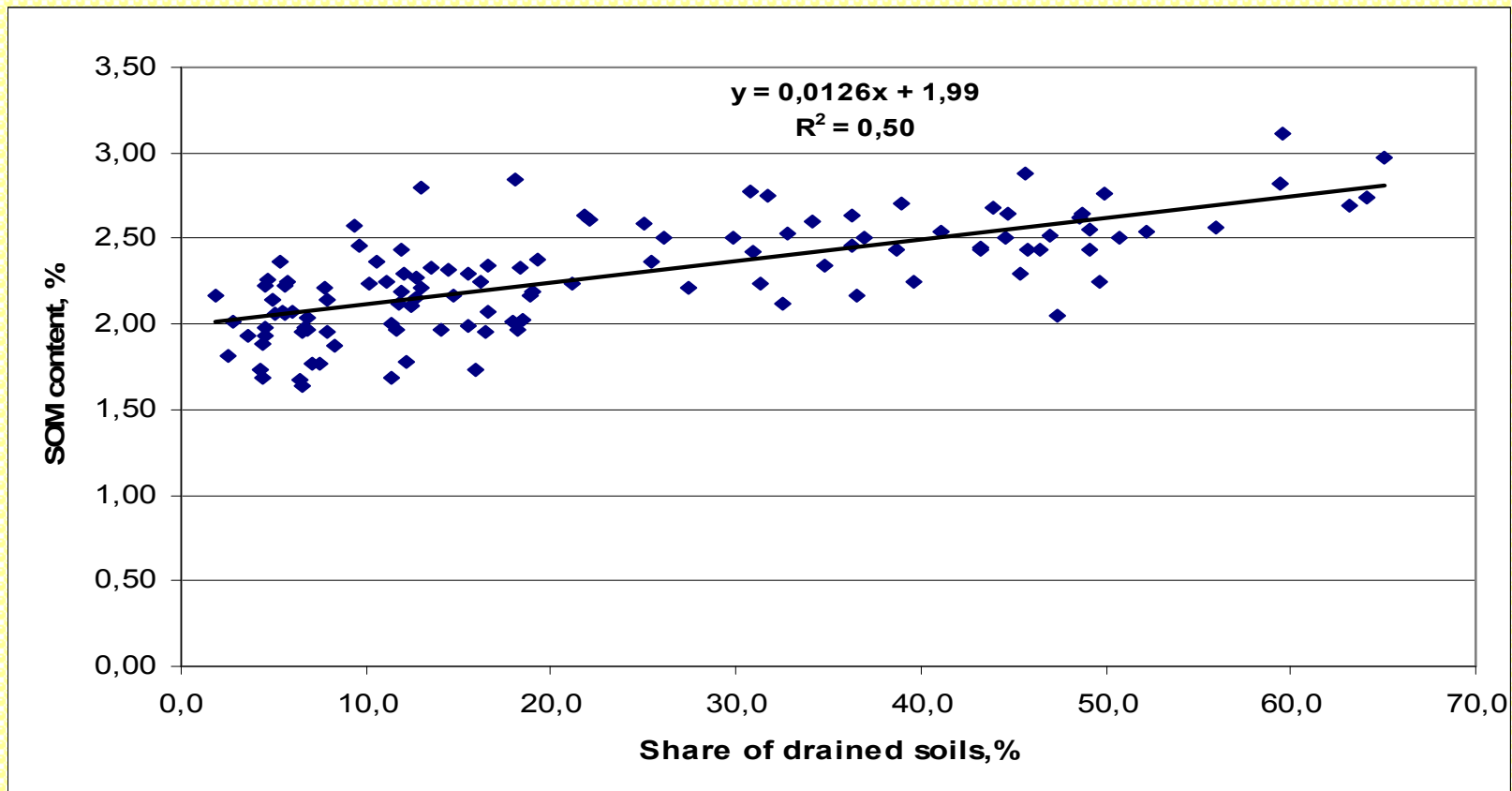
Total RF due to FYM and fertilizers is 2.1-2.2 for ¹³⁷Cs (decreasing with time) and 1.9-2.1 for ⁹⁰Sr (increasing with time).

Accumulation of radionuclides in hay of perennial grass versus the SOM content in Luvisol loamy sand soil

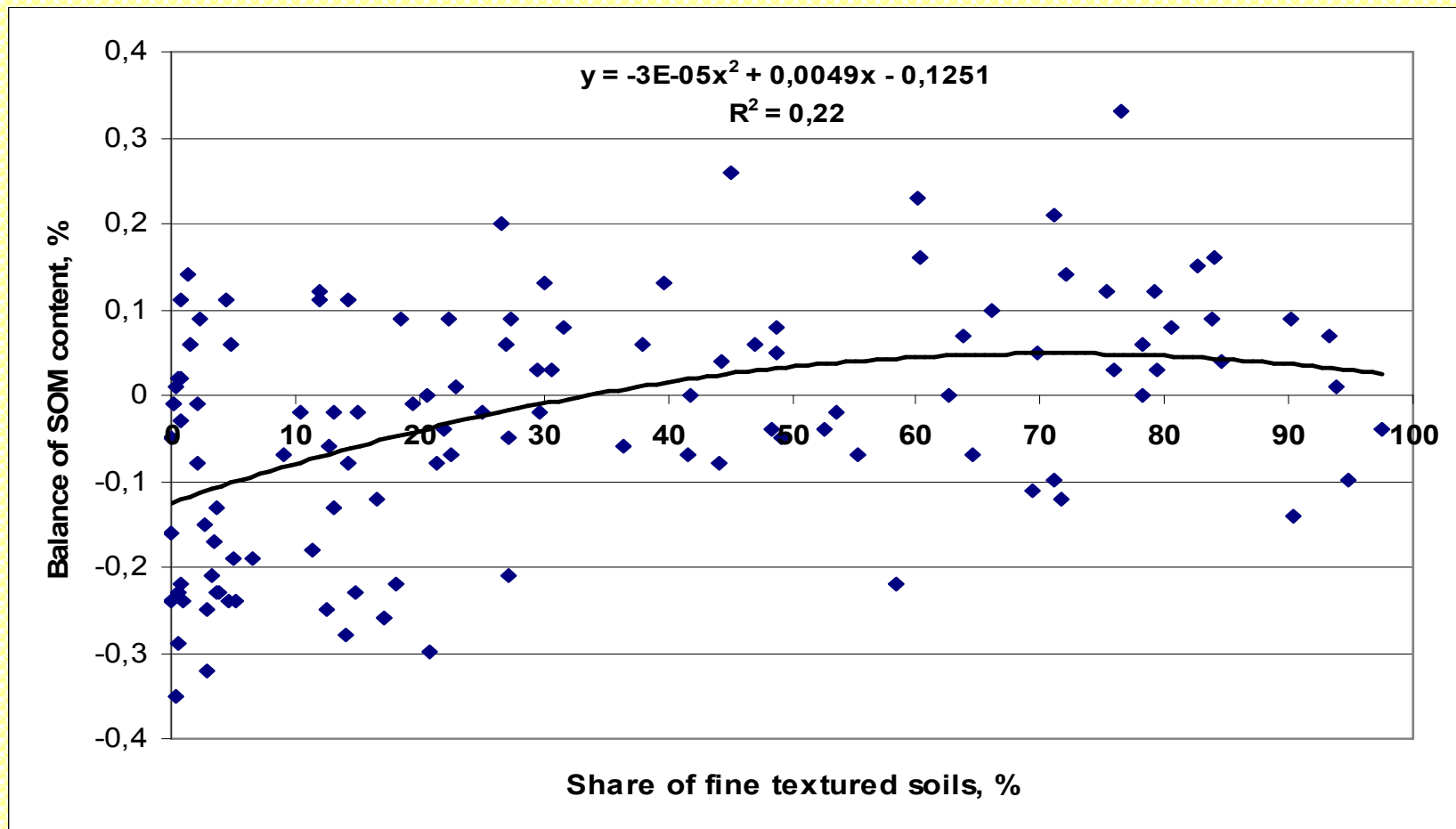
(deposition of ^{137}Cs 370 kBq m⁻² and ^{90}Sr – 37 kBq m⁻²)



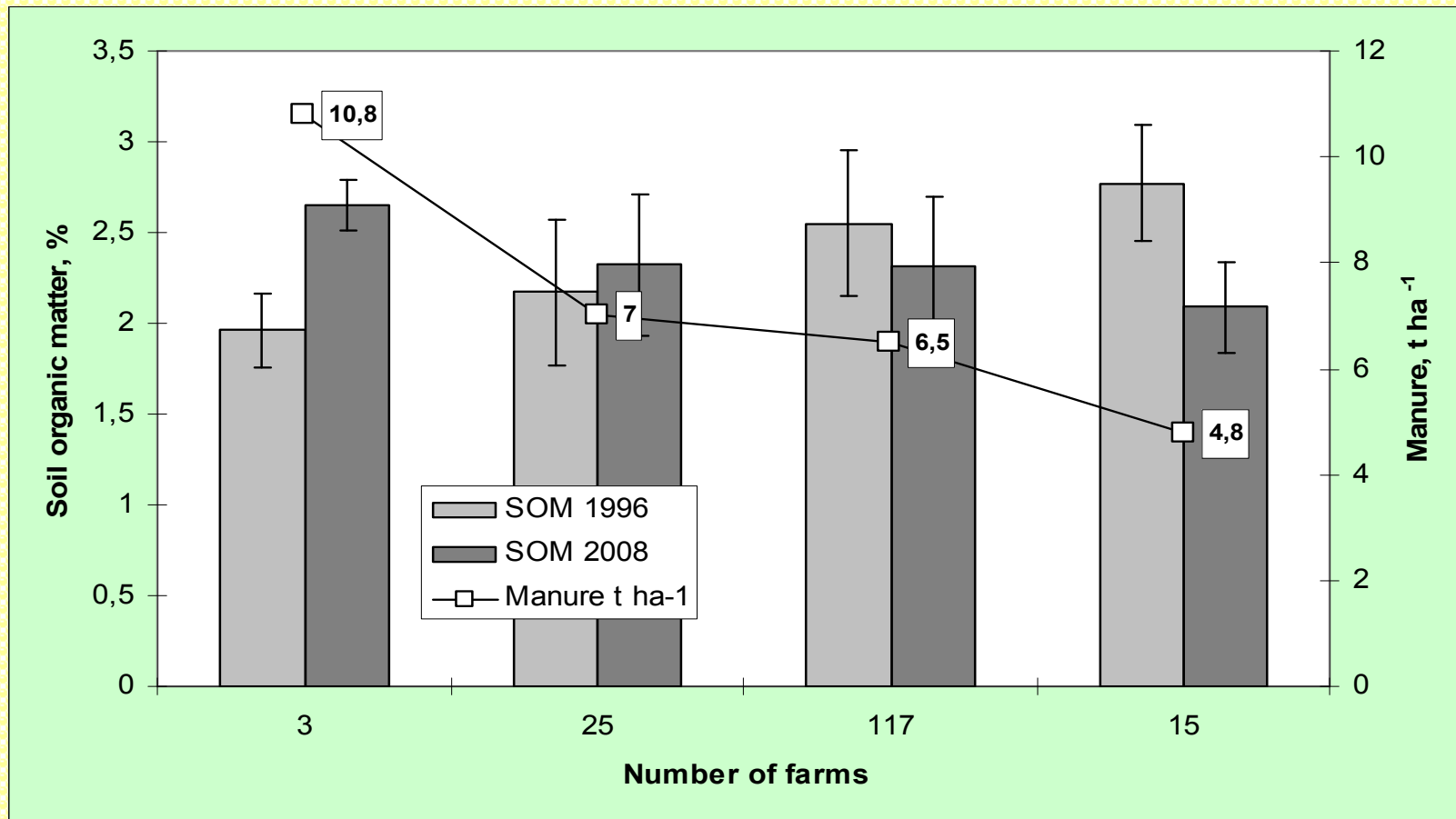
Mean soil organic matter content (%) in arable land related to share of drained soils (%) at 118 districts of Belarus (2005-2008)



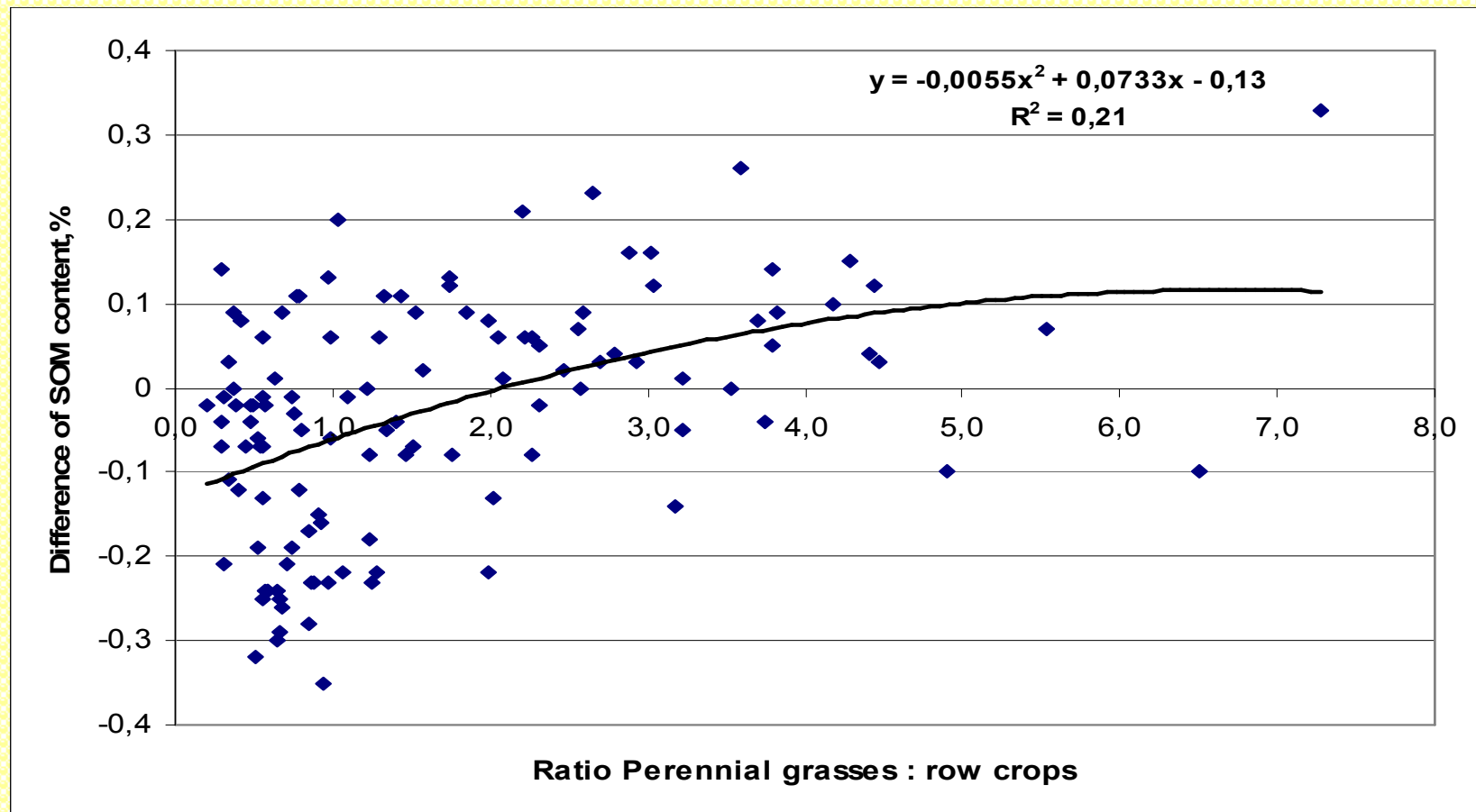
Balance of SOM content for period 1996-2008 related to share of fine textured soils in arable land of 118 districts of Belarus



Dynamics of SOM content at groups of farms related to annual manure rates (1996-2008)



Difference of SOM content for period 1996-2008 related to ratio Perennial grass: row crops at districts of Belarus



Factors related to SOM content balance for period 1996-2008

160 farms of Gomel region

Y - SOM balance differed from 8.2 to -11.5 g kg⁻¹ of soil

in dependence from variables:

- X1 – initial SOM content, g kg⁻¹
- X2 – share of Perennial grass on arable land, %
- X3 – annual rate of manure application, t ha⁻¹
- X4 – annual rate of fertilizer application, NPK kg ha⁻¹

$$Y = 4.21 - 0.3049X_1 + 0.0979X_2 + 0.3633X_3 - 0.0145X_4$$

$$R^2 = 0.38 \quad (p < 0.001)$$

118 districts of Belarus

Y - SOM balance differed from 3.3 to -3.5 g kg⁻¹ of soil

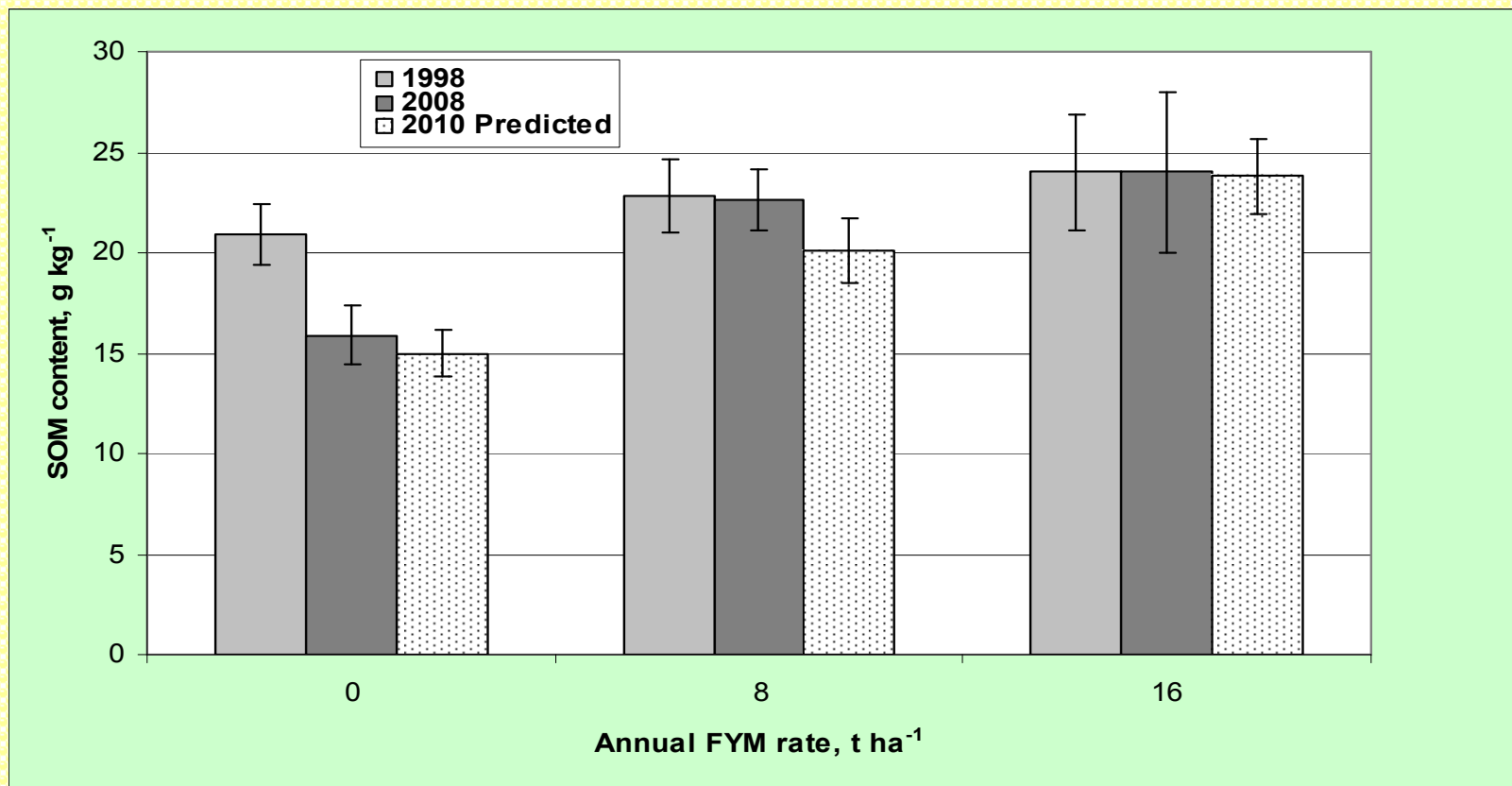
in dependence from variables:

- X1 – initial SOM content, g kg⁻¹
- X2 – share of fine textured soil in arable land, %
- X3 – ratio Perennial grasses: Row crops
- X4 – annual rate of manure application, t ha⁻¹
- X5 – annual rate of fertilizer application, NPK kg ha⁻¹

$$Y = 23.94 - 1.1856X_1 + 0.1199X_2 + 2.3160X_3 + 1.5025X_4 - 0.1013X_5$$

$$R^2 = 0.38 \quad (p < 0.001)$$

Balance of SOM content related to annual FYM rates in long-term experiment on Luvisol loamy sand soil



Experimental data 1998-2008, predicted – 2010. Deviations of predicted from experimental (6-11-1%). Deviation on Luvisol clay loam soil-15%. Deviations on sandy soil (at FYM 7t ha⁻¹ 2-3%, at 14 t ha⁻¹ – 11-16%).

Conclusions

- The soil tests (1996-2008) indicated a fall in SOM content on 60 % of arable land of Belarus. The most significant lost of humus stock in arable layer (in average 5.8 t ha⁻¹ or 6.8% of initial value) was admitted on land of 20 districts contaminated after Chernobyl accident. Ecological function of SOM is related to the reduction of radionuclides ¹³⁷Cs and ⁹⁰Sr accumulation in crop production up to factor 2.
- The long-term prognosis of humus balance on district and farm level is required. However process-based humus balance methods from long-term field experiments are complicate and time consuming. The acceptability of these methods by extension experts and farm managers are rather low.
- To develop simply prognosis tool the analysis of soil monitoring data combined with agricultural statistics on farm and district level had been done. It was found that SOM balance in arable land is closely related to initial level of SOM content, annual rate of FYM application and cropping pattern (share of perennial grass or ratio Perennial grasses: row crops).
- Two multiple linear regression models had been developed which explain up to 38% of SOM balance variations related to mentioned factors at high confidence level (p <0.01). The models were validated against data of long-term experiments making its more applicable for different regions of country.
- The found relationships may be used as a tool to predict and evaluate SOM changes. It may be useful for the selection of reliable management practices to achieve satisfactory and sustainable levels of SOM content. Sustainability in humus reproduction implies the prevention of intolerable decrease as well as excessive increase of the humus content.