



# Experience of the Institute of Biology in Harmonization of Methods for Measuring of Soil Organic Carbon

**Webinar**  
26 September 2023

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# Introduction

**Today, world soil science has a number of national schools that *differ in*:**

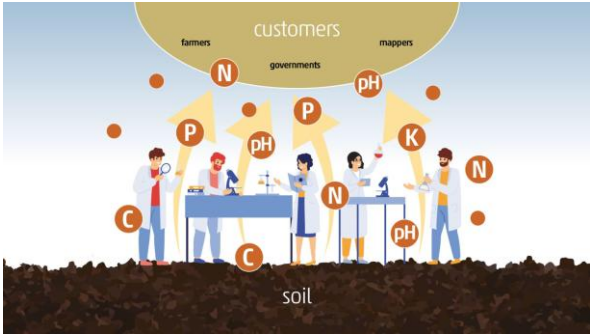
- principles of soil diagnostics,
- approaches (methodology) of study,
- research methods.

**The diversity of schools has historically been caused by:**

- the independent development of soil science in individual countries,
- a wide variety of soils,
- uneven distribution of soils on the earth's surface,
- technical and economic constraints,
- suitability of the method for the soils of the region.



GSP



GLOSOLAN



2011

2013

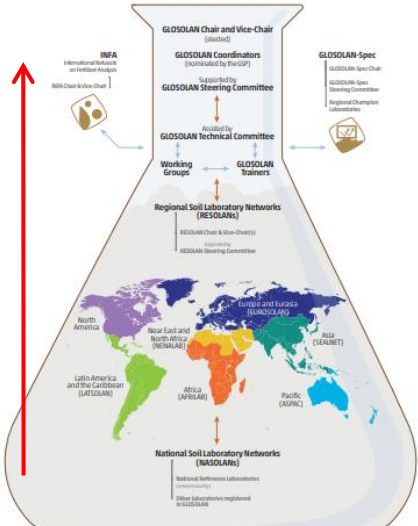
2015

2017

2019

2021

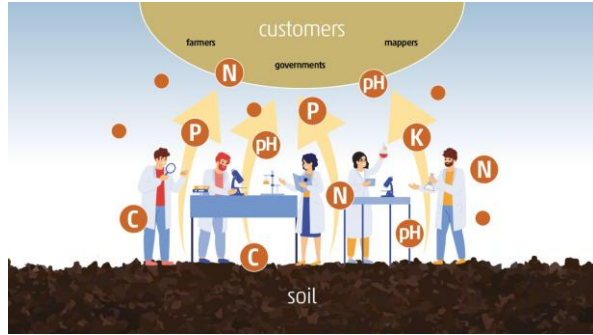
2023



960 laboratories in the world



GSP



GLOSOLAN



2011

2013

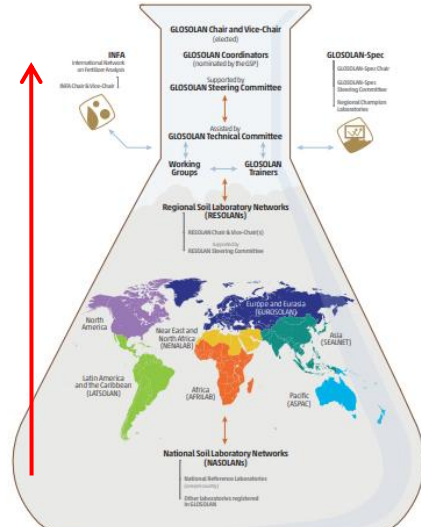
2015

2017

2019

2021

2023



960 laboratories in the world

GLOSOLAN homepage
Soil Analysis
Standard Operating Procedures
Quality Assurance and Quality Control
Health and Safety
Dry chemistry (spectroscopy)
Capacity development
Equipment
Regional Soil Laboratory Networks
National Soil Laboratory Networks
SIMPLE - Soil Import Legislation

Quality assurance (QA) / Quality control (QC)

Quality assurance (QA) focuses on the process of the analysis at the purpose of preventing and/or limiting the occurrence of errors in the measurement.

Quality control (QC) is a set of activities or techniques aiming to ensure that all quality requirements are being met. The continuous monitoring of laboratory operations and results is essential to decide whether the results are reliable enough to be released.

Quality control can be internal or external.

1. Internal quality control: set of procedure undertaken by laboratories to monitor their operations and results.



Basic guidelines for preparing a sample for internal quality control EN | ES



Guidelines for Quality Management in Soil and Plant Laboratories. (FAO Soils Bulletin - 74) EN

2. External quality control (also called "proficiency testing" or "inter-laboratory comparison") is a periodic assessment of the performance of individual laboratories and groups of laboratories. The assessment is done by an independent testing body (like GLOSOLAN) through the distribution of typical materials for unsupervised analysis by the participants. Proficiency testing is used as a tool to assess and enhance standards of the analysis, and assist in the standardization of soil analytical methods across laboratories leading to more reliable and interoperable soil data. Laboratories can use the results obtained in the PT to identify areas where improvements may need to occur.



Guidelines for Quality Management in Soil and Plant Laboratories. (FAO Soils Bulletin - 74)



Basic guidelines on how to produce a soil sample for proficiency testing AR | EN | ES | FR | RU | Zh | TR



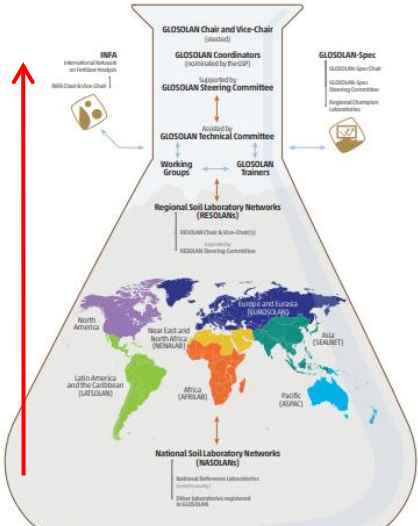
GSP



GLOSOLAN



2011                      2013                      2015                      2017                      2019                      2021                      2023



960 laboratories in the world

# The organization of the GLOSOLAN proficiency test (PT)

GLOSOLAN homepage  
Soil Analysis  
Standard Operating Procedures  
Quality Assurance and Quality Control  
Health and Safety  
Dry chemistry

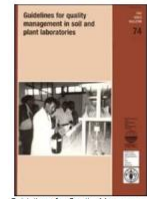
## Quality assurance (QA) / Quality control (QC)

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sample for internal quality control  
EN | ES      Soil and Plant Laboratories (FAO Soils Bulletin - 74)  
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Guidelines for Quality Management in Soil and Plant Laboratories. (FAO Soils Bulletin - 74)



Basic guidelines on how to produce a soil sample for proficiency testing. AR | EN | ES | FR | RU | Zh | TR





# Why SOC?

SOC is one of the **most important components of soils**.

In the age of global changes in the environment, monitoring SOC is of outmost importance.

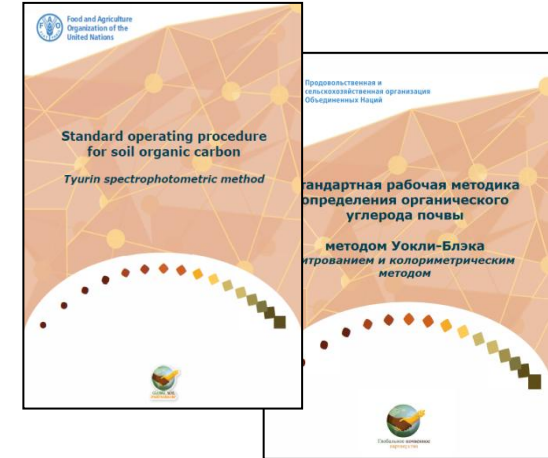
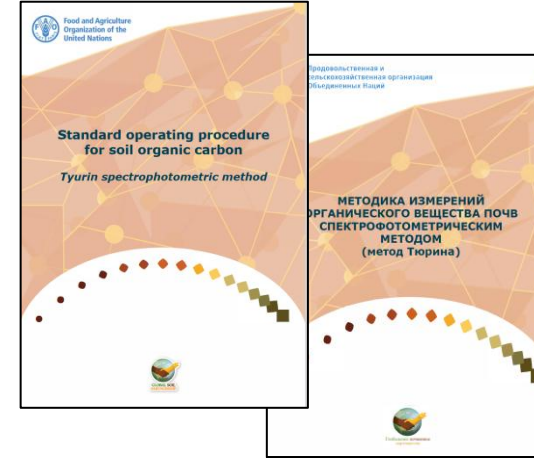
Under the Global Soil Partnership initiative of the Food and Agriculture Organization of the United Nations (FAO), the availability of non-harmonized data is one of the reasons for the low accuracy of the global SOC map (*Peralta et al., 2022*).

***This is especially true for regions such as Eurasia where data are sparse.***

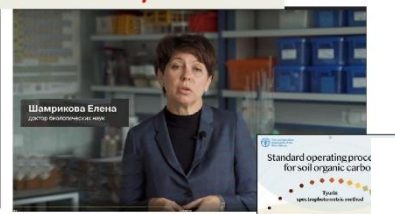


# Tested methods

- Tyurin's method (T),
- Walkley-Black's method (WB),
- Dry combustion on the analyzer (DC),
- Loss-on-ignition method (LOI)

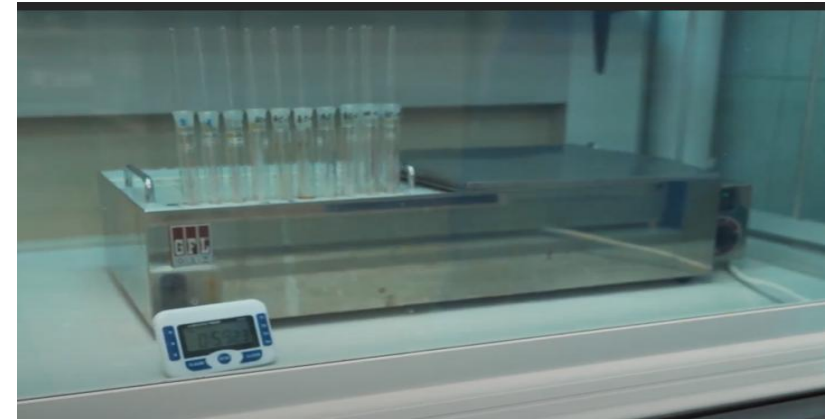
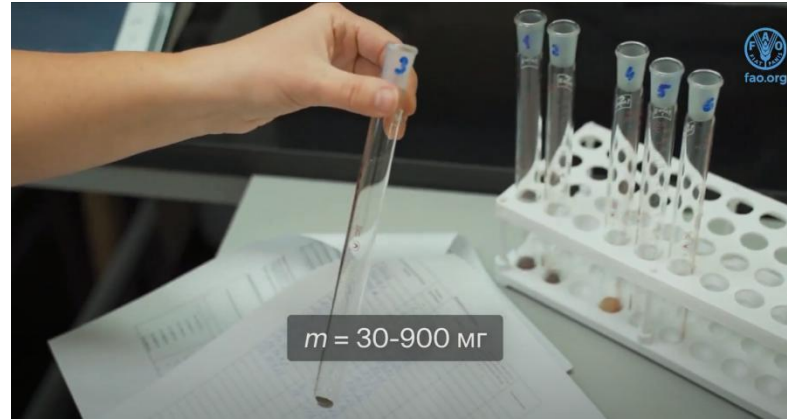


Almost 9000 views in one year!



# Tyurin's method (Institute of Biology)

1



2



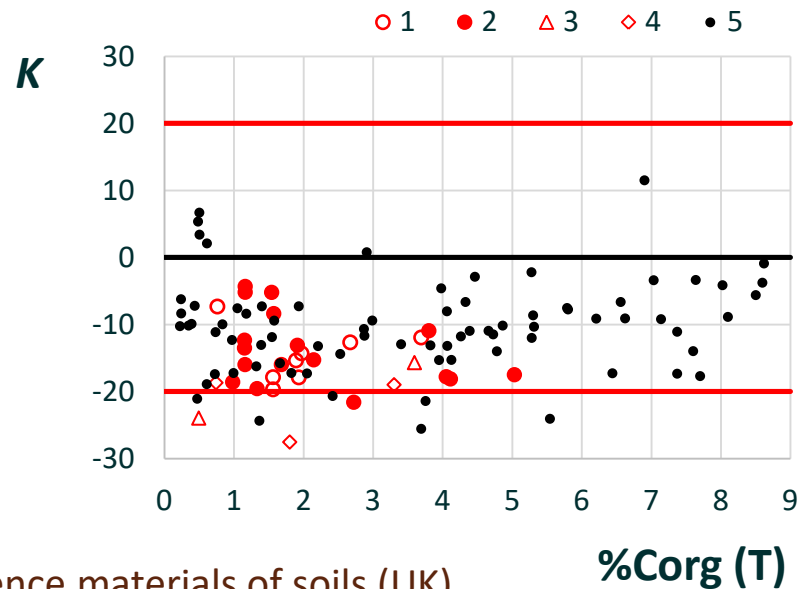
3





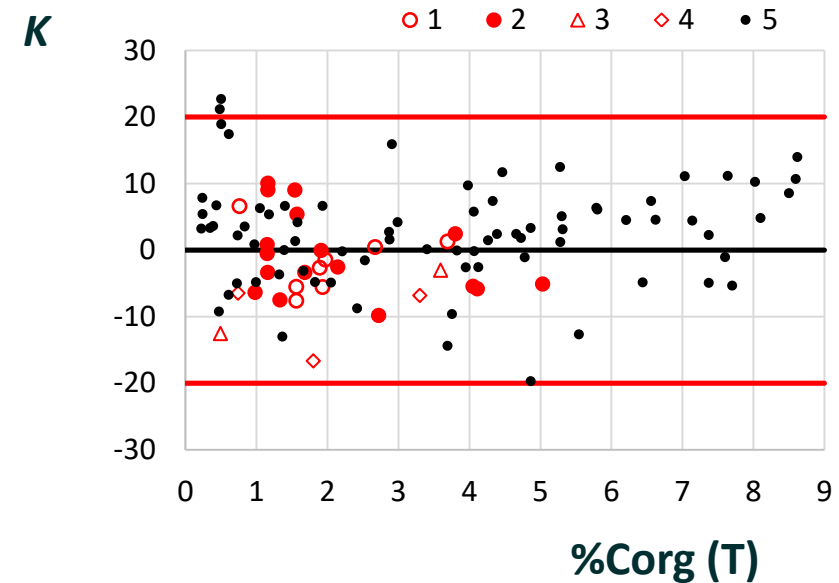
# Quality control of measurements %Corg (Tyurin)

without taking into account the  $f = 1.15$



- 1 – reference materials of soils (UK)
  - 2, 3 – standard soil samples (Russia)
  - 4 – soil samples from GLOSOLAN**
  - 5 – soil samples of various types
- more than 120 soil samples in total

taking into account the  $f = 1.15$



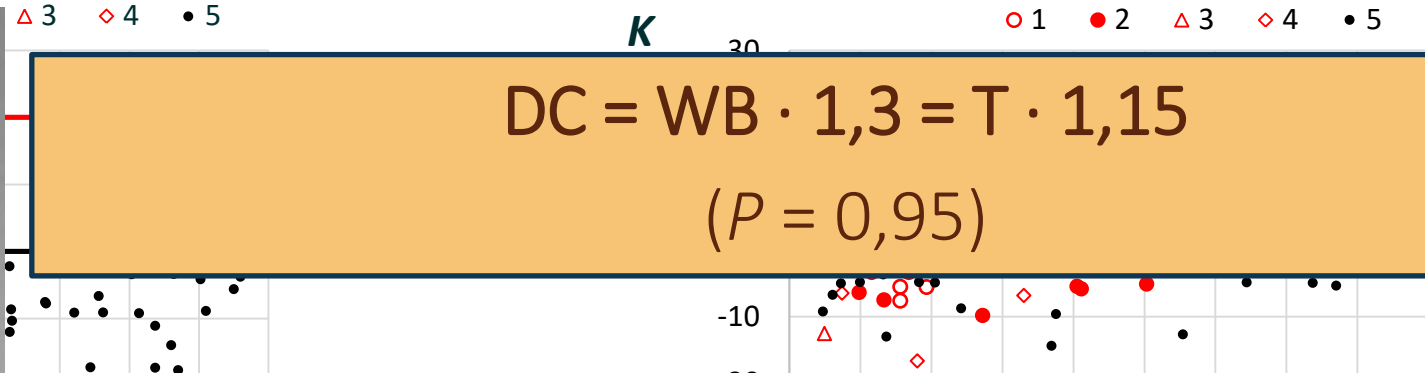
%Corg (T)	$K, \% (P = 0.,95)$
0.170 – 8.,7	20

$$K = 100\% * \frac{|\%Corg (T) - \%Corg (DC)|}{\%Corg (DC)}$$

# Quality control of measurements %Corg (Tyurin)

without taking into account the  $f = 1.15$

taking into account the  $f = 1.15$



$$DC = WB \cdot 1,3 = T \cdot 1,15$$

$$(P = 0,95)$$

Ivan Vladimirovich Tyurin (1892-1962)  
 $f = 1.17$  (Arinushkina, 1962)

%Corg (T)	$K, \% (P = 0.95)$
0.170 – 8.7	20

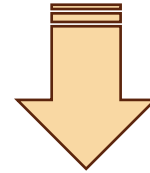
$$K = 100\% * \frac{|\%Corg (T) - \%Corg (DC)|}{\%Corg (DC)}$$



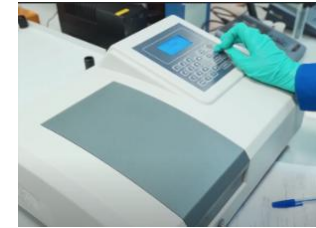
$$DC = WB \cdot 1.3 = T \cdot 1.15$$
$$(P = 0.95)$$

! In the Walkley-Black method, the amount of  $K_2Cr_2O_7$  and  $H_2SO_4$  is equal to the same characteristics as in the Tyurin method, but the concentration of these components of the mixture is 1.5 times higher

!! Heating of the reaction mixture occurs due to the exothermic effect that occurs when a concentrated solution of  $H_2SO_4$  is mixed with distilled water.



In the Tyurin method, compared to WB, additional dispersion of the solid phase occurs

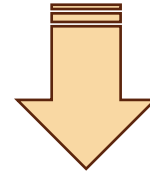


$$DC = WB \cdot 1.3 = T \cdot 1.15$$

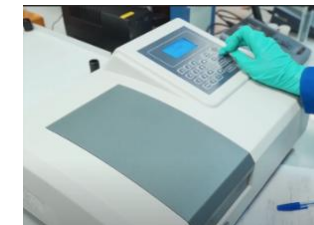
$$(P = 0.95)$$

of  $K_2Cr_2O_7$  and  $H_2SO_4$  is equal to the same characteristics as in  
 on of these components of the mixture is 1.5 times higher

due to the exothermic effect that occurs when a concentrated  
 $SO_4$  is mixed with distilled water.



o WB, additional dispersion of the solid phase occurs



Contents lists available at [ScienceDirect](#)

**Geoderma**

journal homepage: [www.elsevier.com/locate/geoderma](http://www.elsevier.com/locate/geoderma)

Transferability between soil organic matter measurement methods for database harmonization

E.V. Shamrikova<sup>a</sup>, B.M. Kondratenok<sup>a</sup>, E.A. Tumanova<sup>a</sup>, E.V. Vanchikova<sup>a</sup>, E.M. Lapteva<sup>a</sup>, T. V. Zonova<sup>a</sup>, E.I. Lu-Lyan-Min<sup>a</sup>, A.P. Davydova<sup>a</sup>, Z. Libohova<sup>b,\*</sup>, N. Suvannang<sup>c</sup>

<sup>a</sup> Institute of Biology Komi SC Urd RAS, Kommunisticheskay 28, Syktyvkar, Russian Federation  
<sup>b</sup> USDA-ARS Dale Bumpers Small Farms Research Center, 6883 S. Hwy 23, Booneville, AR 72927, United States  
<sup>c</sup> Land Development Department, 2003/61 Phaholyothin Road, Chatuchak, Bangkok 10240, Thailand

ARTICLE INFO ABSTRACT

Handling Editor: Ingrid Kögel-Knabner Soil organic matter (SOM) is one of the most important soil-forming factors and complex with a chemical

Catena xxx (xxxx) 107151

Contents lists available at [ScienceDirect](#)

**Catena**

journal homepage: [www.elsevier.com/locate/catena](http://www.elsevier.com/locate/catena)

Which method to choose for measurement of organic and inorganic carbon content in carbonate-rich soils? Advantages and disadvantages of dry and wet chemistry

E.V. Shamrikova, E.V. Vanchikova, E.I. Lu-Lyan-Min, O.S. Kubik, E.V. Zhangurov

Institute of Biology Komi SC Urd RAS, Kommunisticheskay 28, Syktyvkar, Russian Federation



# Dichromatometric method (T, WB)

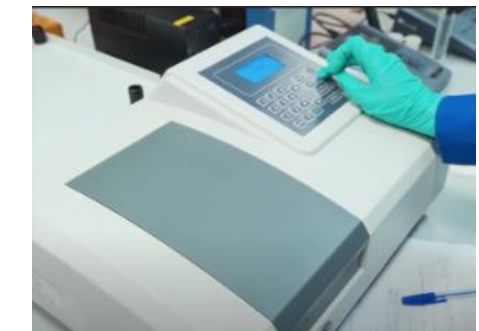
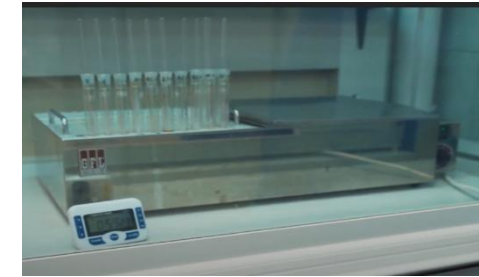
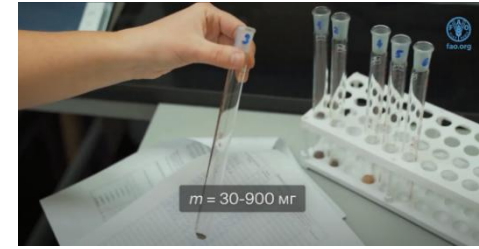
## Advantages:

- cheapness,
- significant amounts of data on the world's soils

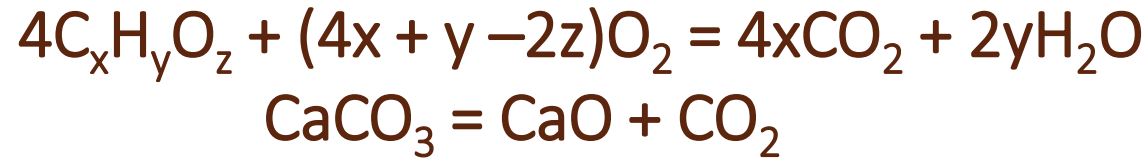
## Disadvantages:

- limited measurement range %Corg from **0.17 to 8.7%**,
- incomplete oxidation of carbon of organic compounds (taking into account the incomplete oxidation of Corg - using universal  $f$ ),
- labor intensity,
- toxicity.

Relative measurement error:  $\pm\delta = 20\%$ .



# Dry combustion on the analyzer



## Advantages:

- measuring range %C<sub>tot</sub> from 0.1 to 100%,
- high accuracy of measurement results:  
 $\pm\delta = 23, 15, 10$  и  $3,5\%$  для %C<sub>tot</sub> = (01–2); (2–5) и (5–30) и  $>30\%$ ,
- complete oxidation of carbon of organic and inorganic compounds,
- availability of standard samples for analyzer calibration,
- rapidity (batch up to 100 samples),
- selectivity

## Disadvantages:

High cost of the device, consumables and maintenance



Reference  
method

# Loss-on-ignition method

## Advantages:

- cheapness,
- measuring range %C<sub>tot</sub> from 0.1 to 100%,
- rapidity

## Disadvantages:

- ??  $f$  for SOM  $\rightarrow$  SOC (SOC = SOM / 1.724),
- the presence of mineral compounds that decompose at  $T = 105-550^{\circ}\text{C}$  with the release of gaseous products



## 27 September – 15 November 2023

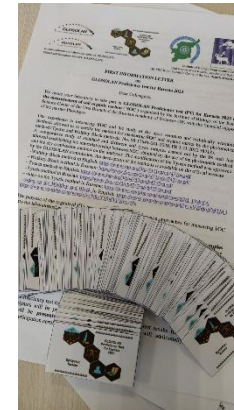
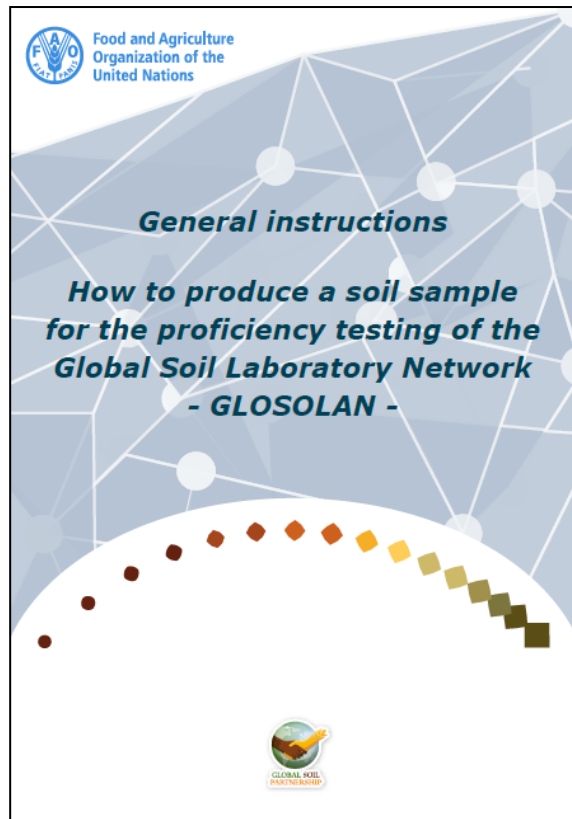
Method	Soil A			Soil B			Soil C			Soil D			Soil E			Soil F			Soil G			Soil H			Soil I		
<b>1 - T</b>	A1 <sub>1</sub>	A1 <sub>2</sub>	A1 <sub>3</sub>	B1 <sub>1</sub>	B1 <sub>2</sub>	B1 <sub>3</sub>	C1 <sub>1</sub>	C1 <sub>2</sub>	C1 <sub>3</sub>	D1 <sub>1</sub>	D1 <sub>2</sub>	D1 <sub>3</sub>	E1 <sub>1</sub>	E1 <sub>2</sub>	E1 <sub>3</sub>	F1 <sub>1</sub>	F1 <sub>2</sub>	F1 <sub>3</sub>	G1 <sub>1</sub>	G1 <sub>2</sub>	G1 <sub>3</sub>	H1 <sub>1</sub>	H1 <sub>2</sub>	H1 <sub>3</sub>	I1 <sub>1</sub>	I1 <sub>2</sub>	I1 <sub>3</sub>
<b>2 - WB</b>	A2 <sub>1</sub>	A2 <sub>2</sub>	A2 <sub>3</sub>	B2 <sub>1</sub>	B2 <sub>2</sub>	B2 <sub>3</sub>	C2 <sub>1</sub>	C2 <sub>2</sub>	C2 <sub>3</sub>	D2 <sub>1</sub>	D2 <sub>2</sub>	D2 <sub>3</sub>	E2 <sub>1</sub>	E2 <sub>2</sub>	E2 <sub>3</sub>	F2 <sub>1</sub>	F2 <sub>2</sub>	F2 <sub>3</sub>	G2 <sub>1</sub>	G2 <sub>2</sub>	G2 <sub>3</sub>	H2 <sub>1</sub>	H2 <sub>2</sub>	H2 <sub>3</sub>	I2 <sub>1</sub>	I2 <sub>2</sub>	I2 <sub>3</sub>
<b>3 - DC</b>	A3 <sub>1</sub>	A3 <sub>2</sub>	A3 <sub>3</sub>	B3 <sub>1</sub>	B3 <sub>2</sub>	B3 <sub>3</sub>	C3 <sub>1</sub>	C3 <sub>2</sub>	C3 <sub>3</sub>	D3 <sub>1</sub>	D3 <sub>2</sub>	D3 <sub>3</sub>	E3 <sub>1</sub>	E3 <sub>2</sub>	E3 <sub>3</sub>	F3 <sub>1</sub>	F3 <sub>2</sub>	F3 <sub>3</sub>	G3 <sub>1</sub>	G3 <sub>2</sub>	G3 <sub>3</sub>	H3 <sub>1</sub>	H3 <sub>2</sub>	H3 <sub>3</sub>	I3 <sub>1</sub>	I3 <sub>2</sub>	I3 <sub>3</sub>
<b>4 - LOI</b>	A4 <sub>1</sub>	A4 <sub>2</sub>	A4 <sub>3</sub>	B4 <sub>1</sub>	B4 <sub>2</sub>	B4 <sub>3</sub>	C4 <sub>1</sub>	C4 <sub>2</sub>	C4 <sub>3</sub>	D4 <sub>1</sub>	D4 <sub>2</sub>	D4 <sub>3</sub>	E4 <sub>1</sub>	E4 <sub>2</sub>	E4 <sub>3</sub>	F4 <sub>1</sub>	F4 <sub>2</sub>	F4 <sub>3</sub>	G4 <sub>1</sub>	G4 <sub>2</sub>	G4 <sub>3</sub>	H4 <sub>1</sub>	H4 <sub>2</sub>	H4 <sub>3</sub>	I4 <sub>1</sub>	I4 <sub>2</sub>	I4 <sub>3</sub>



# Before the start of PT



## Preparation of soil samples for PT





# During PT



## Stability

which determines the period life of the soils.

10 times 1-2 parallel replicates for each sample for each method.

= 10-20 measurements for each sample for each method.

The measurement period is from the beginning of PT to the end of PT.

1 or 2 times a week.


Later we will calculate the frequency of measurements.



# Conclusion

27 September – 15 November 2023

<https://ib.komisc.ru/rusolan/>



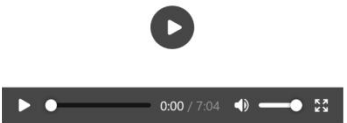
**РУСОЛАН**

Российская сеть почвенных лабораторий РУСОЛАН (RUSOLAN) — национальное подразделение, которое является частью Глобальной сети почвенных лабораторий ГЛОСОЛАН (GLOSOLAN), координируемой Глобальным почвенным партнерством Продовольственной и сельскохозяйственной организации ООН (Food and Agriculture Organization of the United Nations (FAO), Italy-Rome, <https://www.fao.org/global-soil-partnership/glosolan-old/national-soil-laboratory-networks/country/russian-federation/en/>). Постоянным партнером деятельности РУСОЛАН с момента организации национальной сети выступает ПАО "ФосАгро".

Регистрация и членство в сети бесплатны.

<b>Председатель РУСОЛАН</b>	<b>ШАМРИКОВА Елена Вячеславовна</b> (Россия, Республика Коми, г. Сыктывкар) <ul style="list-style-type: none"><li>• тел.: +7 (8212) 24-51-15</li><li>• e-mail: shamrik@ib.komisc.ru</li></ul>
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- Видеоэкскурсия по Национальной референтной лаборатории РУСОЛАН
- Известия Коми научного центра Уральского



GLOSOLAN Proficiency test for Eurasia 2023 are held **free of charge**.

All PT participants will be provided with a final report in which test results from participating laboratories will be **presented anonymously**.

Every participant will additionally receive an individual PT **participation certificate**.

# Acknowledgments



THANK YOU  
FOR ATTENTION!

