Food and Agriculture Organization of the United Nations

Global Soil Laboratory Assessment

Laboratories capacities and needs

2020

GLOBAL SOIL PARTNERSHIP

2020 | Global Soil Laboratory Assessment

Laboratories' capacities and needs

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Preface

In the five years that have elapsed since the International Year of Soils in 2015 the urgent need for global implementation of sustainable soil management has been widely recognized by civil society, governments and international organizations. The selection of the most effective techniques to achieve long-term sustainability often hinges, however, on reliable data on the current condition of the soil. For example, allocating scarce resources to remediate contaminated soil requires reliable data on the level of soil pollutants present at contaminated sites; targeting nutrient additions to achieve optimum plant growth requires accurate data on the nutrient-supplying power of the soils; and determining the capacity of a soil to absorb carbon from the atmosphere (i.e., carbon sequestration) can only be determined when a reliable measure of current soil organic carbon stores is available. These management decisions and a host of others involved in sustainable soil management all require the availability of reliable information on soil properties.

Such information is provided by laboratories that analyze soil samples from the field and produce data on soil biological, chemical, and physical properties. The importance of soil laboratories was recognized in the Pillars of Action of the Global Soil Partnership and Pillar 5 on the harmonization of methods, measurements and indicators for sustainable management and the protection of soil resources has been central to the work of the GSP since its establishment in 2012.

The Global Soil Laboratory Network (GLOSOLAN) was established in November 2017 to carry out the Plan of Action for Pillar 5. Ultimately, GLOSOLAN aims to (1) make soil information comparable and interpretable across laboratories, countries and regions, (2) build a set of agreed upon harmonization principles, (3) improve quality assurance (QA) and quality control (QC) of soil analyses, and (4) promote the exchange of information and experience to develop capacities wherever needed. Indeed, it is only by having sufficient, available, reliable and comparable soil information that sustainable soil management can be promoted and implemented.

This report presents the status of soil laboratories around the world, providing with an excellent overview of the state of the art of the services provided by these laboratories, the available resources, the challenges they face and how they could be addressed in order to enhance the generation of reliable soil data for sustainable soil management.

1. Introduction

This report is based on the answers provided by soil laboratories to the survey "global assessment on laboratory capacities and needs" (see Annex II), which was conducted by the Global Soil Laboratory Network (GLOSOLAN) under the framework of the Global Soil Partnership of the Food and Agriculture Organization of the United Nations.

Online surveys are known to be the best and fastest way to collect information for large-scale monitoring and evaluation. In 2018, a first global survey was launched by GLOSOLAN to collect information to consolidate the objectives of the network and define its work plan in terms of standard operating procedures for harmonization. The survey discussed in this report aimed at collecting information on laboratories' training and equipment needs and at assessing the capacity of laboratories to satisfy national demands in soil analysis. In this regard, questions were not laboratory specific but country oriented. These data will serve to improve the GLOSOLAN work plan in terms of activities, budget allocation and provision of country-specific political support. It can also help to mobilize financial resources and to develop better nationally and regionally oriented work plans on soil laboratories.

1.1. Participation in the survey

The survey was completed by 241 laboratories from 142 different countries (see Annex I). The list of countries responding the survey is herewith organized by regions:

- **Africa**:
  Total number of countries in the region: 48
  Total number of responding countries to the survey: 35
  Botswana, Burkina Faso, Cameroon, Cape Verde, Democratic Republic of Congo, Djibouti, Eswatini, Ethiopia, Gabon, Ghana, Republic of Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Africa, South Sudan, Tanzania, Togo, Zambia, Zimbabwe
- **Asia**:
  Total number of countries in the region: 25
  Total number of responding countries to the survey: 19
  Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand, Vietnam
- **Europe**:
  Total number of countries in the region: 42
  Total number of responding countries to the survey: 30
  Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Israel, Italy, Kosovo[1], Latvia, Netherlands, North Macedonia, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom
- **Eurasia:**
  Total number of countries in the region: 12
  Total number of responding countries to the survey: 10
  Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russian Federation, Tajikistan, Ukraine, Uzbekistan

[1] *References to Kosovo shall be understood to be in the context of Security Council Resolution 1244 (1999).*

- **Latin America and the Caribbean:**
  Total number of countries in the region: 41
  Total number of responding countries to the survey: 27
  Antigua and Barbuda, Argentina, Bahamas, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Paraguay, Panama, Peru, Saint Lucia, Trinidad and Tobago, Uruguay, Venezuela
- **Near East and North Africa (NENA):**
  Total number of countries in the region: 19
  Total number of responding countries to the survey: 13
  Bahrain, Iran, Iraq, Jordan, Kuwait, Lebanon, Morocco, Palestine, Sudan, Syria, Tunisia, United Arab Emirates, Yemen
- **North America:**
  Total number of countries in the region: 2
  Total number of responding countries to the survey: 1
  United States of America
- **Pacific:**
  Total number of countries in the region: 18
  Total number of responding countries to the survey: 7
  Australia, Fiji, Guam, New Caledonia, New Zealand, Papua New Guinea, Samoa
  Please note that the limited response from countries in the Pacific is due to the absence of soil laboratories in the majority of Pacific Islands states.

The African region was that providing the largest number of feedbacks, see *figure 1*.

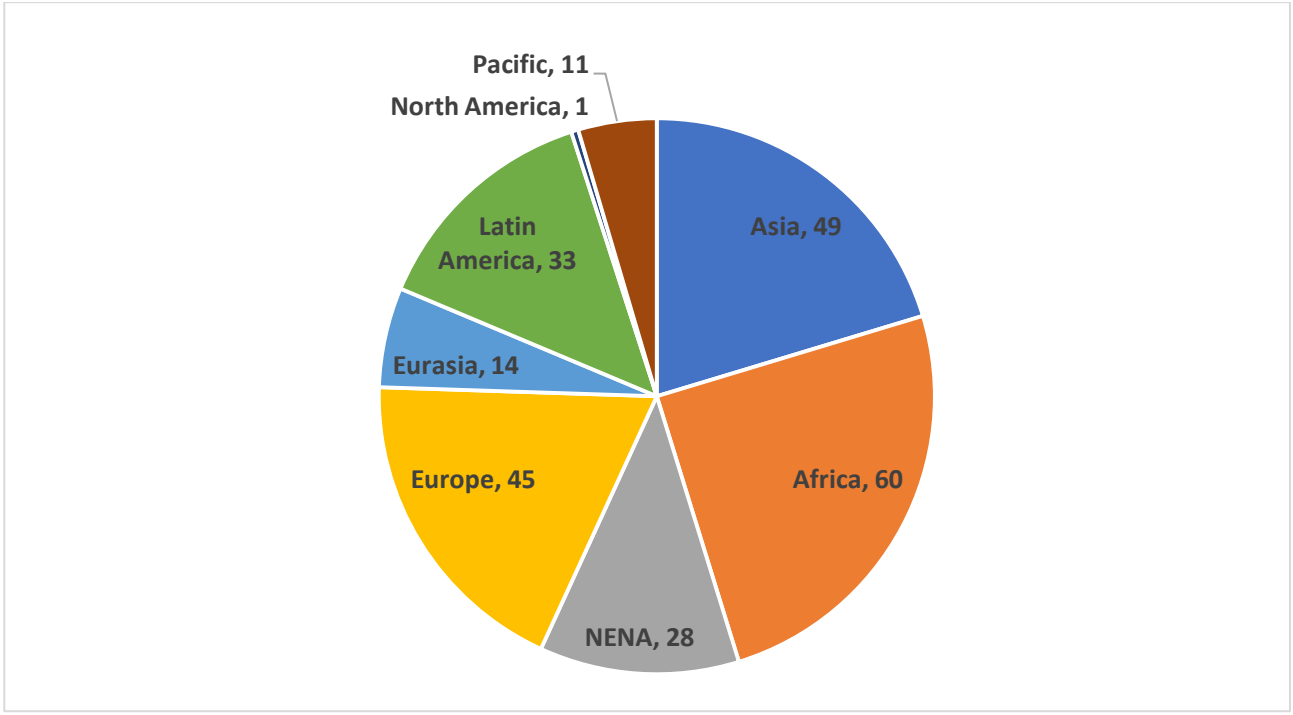


Figure 1. Participation in the survey by region (numbers indicate the responses)

1.2. Structure of the survey

The survey consisted of 11 questions (see Annex I), herewith organized into four thematic sections.

Section 1: General information

- **Number of private and public soil laboratories operating in the country**. The objective here was to learn about the capacity of a country to analyze soil samples.
- **Country demand vs analytical capacity.** This question was asked to learn if the number and capacity of existing laboratories was sufficient to cover the country demand for soil analysis.

Section 2: Facilities and staff

- **Average conditions of soil laboratories**. The objective here was to learn if the laboratory infrastructure and equipment were generally well maintained and functional
- **Average qualification of laboratory staff**. This question enquired about the level of education of laboratory staff and their potential need for training.

Section 3: Soil analysis

- **Type of services offered by laboratories in the country**. This question surveyed the execution of three major types of soil analysis: chemical, physical and biological.
- **Use of innovative technologies like spectroscopy**. Two questions on soil spectroscopy were asked. On one hand, the survey asked respondents to indicate if this technology is used at all in their country and by whom. On the other hand, the interest of participants to start using this technology was surveyed. These questions identified interested respondents for follow up by the GLOSOLAN working group on spectroscopy.
- **Association to international standards like ISO.** The objective here was to learn about the accreditation of laboratories in soil analysis
- **Use of quality control processes.** This question was asked to learn if laboratory operations and results are monitored and validated.

Section 4: Laboratory needs

- **Technical assistance services offered by manufacturers**. This question was asked in recognition that many laboratories have problems receiving technical assistance and training in the use of the equipment they purchase. Since GLOSOLAN is promoting best practices in the purchasing and use of laboratory equipment, and it is approaching manufacturers to improve their technical assistance services at the country and regional level, this question helped to identify those countries in which GLOSOLAN support is needed the most.
- **General needs.** The information provided by laboratories in here will help GLOSOLAN to review its work plan in terms of training and to reformulate its requests for financial support to donors. Depending on the request for support (e.g. better waste management policies) political actions will be undertaken as needed.

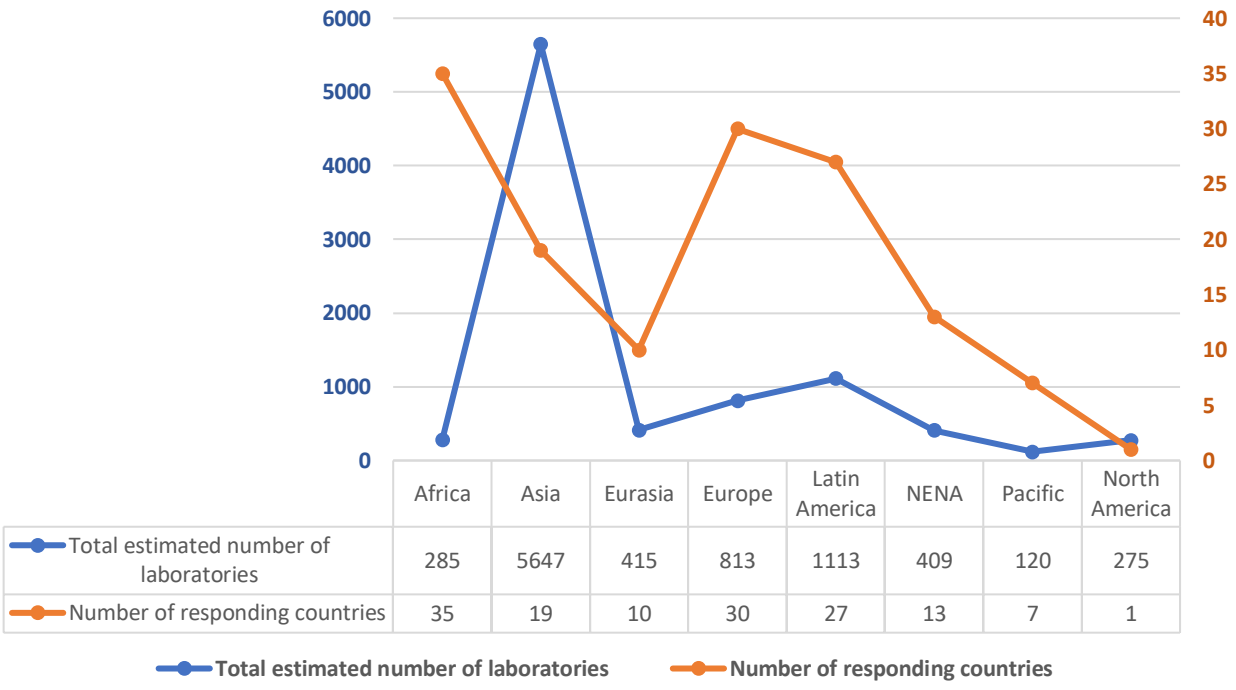
2. Results and discussions

Results are presented and discussed according to the four thematic sections previously identified.

2.1. General information

As shown in *figure 2*, the largest number of laboratories is located in Asia (5 647), with a remarkable gap with the values for other regions. The same graph shows the small number of soil laboratories in Africa (285), which is also the region where the highest percentage of survey responses from countries came from.

Results revealed that the estimated number of private and public laboratories present in the different countries are quite similar on average. Extreme cases are present in North America, where the estimated number of private soil laboratories is almost three times bigger than the public ones, and in the African and Asian regions, where the estimated number of public soil laboratories represent around 78 percent of the total (*figure 3*).



	Africa	Asia	Eurasia	Europe	Latin America	NENA	Pacific	North America
Total estimated number of laboratories	285	5647	415	813	1113	409	120	275
Number of responding countries	35	19	10	30	27	13	7	1

Figure 2. Graph showing the estimated number of laboratories over the responding countries.

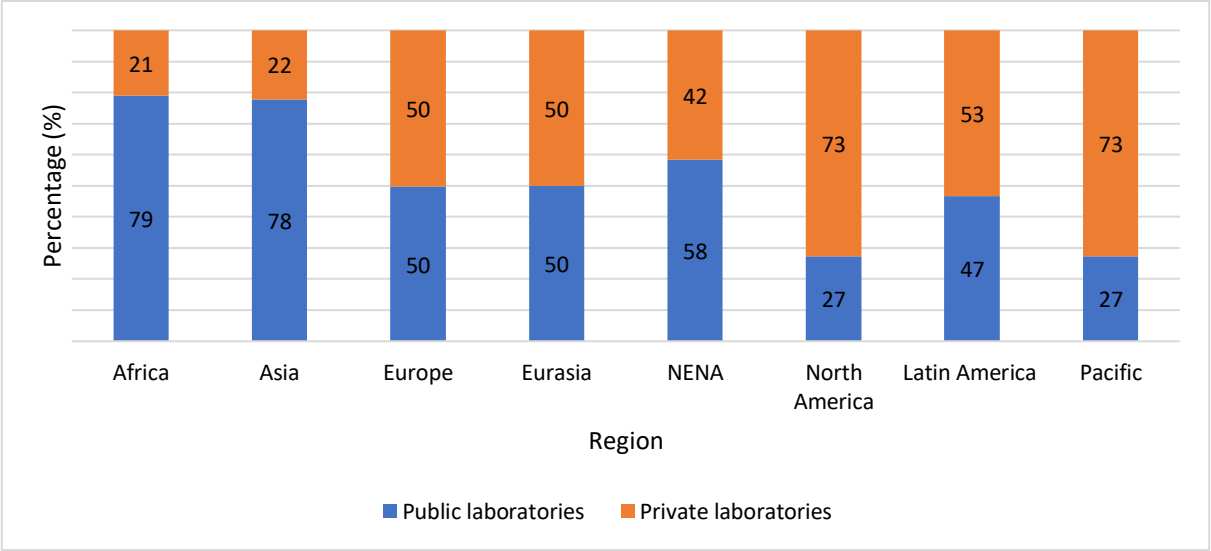


Figure 3. Number of public and private soil laboratories operating in the different regions.

Soil laboratory services seemed to be adequate to cover the national demand in soil analysis in 45 percent of responding countries. The countries where services were not sufficient are Afghanistan, Antigua and Barbuda, Azerbaijan, Bahamas, Bangladesh, Barbados, Botswana, Bulgaria, Cambodia, Capo Verde, Colombia, Democratic Republic of Congo, Denmark, Djibouti, Eswatini, Ethiopia, Gabon, Greece, Republic of Guinea, Guyana, Haiti, Iraq, Kazakhstan, Kenya, Kyrgyzstan, Laos, Lebanon, Liberia, Madagascar, Mauritania, Mexico, Morocco, Namibia, Nepal, New Caledonia, Pakistan, Paraguay, Philippines, Republic of Korea, Rwanda, Senegal, Somalia, South Sudan, Sri Lanka, Saint Lucia, Tajikistan, The Republic of Moldova, Togo, Trinidad and Tobago, and Zimbabwe.

Figure 4 shows the relation between analytical capacities and country demands in the different regions. Please note that the class “maybe” was used when respondents from a same country provided contradictory information.

The graph highlights a severe situation in Africa, Asia and Eurasia where many countries have analytical services that cannot meet the national demand. In these regions, there is the need for major investments to build the capacity of existing laboratories and to establish new laboratories as needed.

The majority of countries in other regions stated that they have adequate analytical capacities to address national demands in soil analysis.

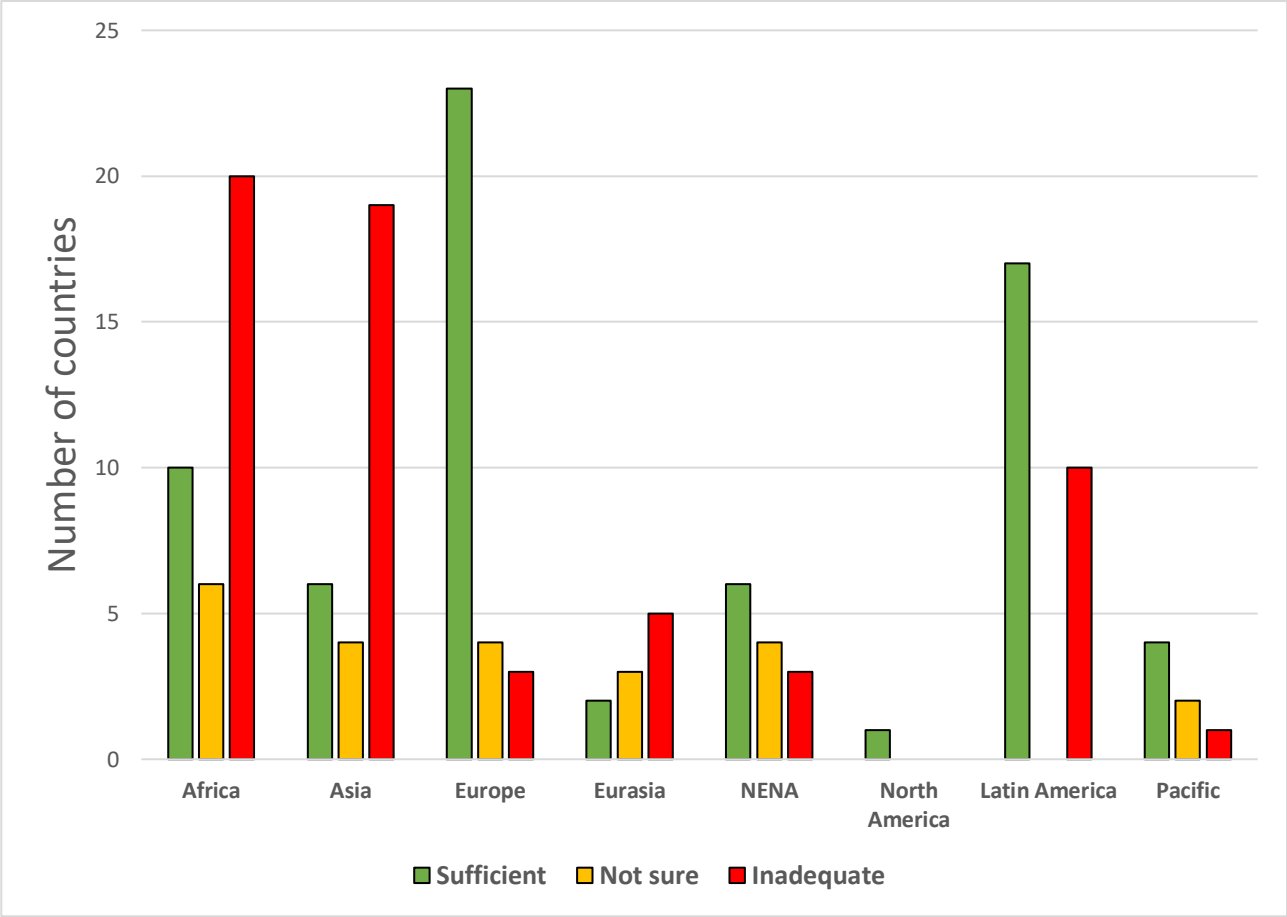


Figure 4. National analytical capacity against country demand, on regional basis.

Green bars represent a sufficient analytical capacity of the country; red bars mean that the available soil laboratory services are not enough to cover the country's demand; yellow bars stand for uncertain feedbacks to the question.

2.2. Facility and staff

Only 38 countries reported that, on average, they have soil laboratories in good conditions with infrastructure and equipment that are well maintained and able to carry out the workload. On the other hand, 92 countries reported that they have soil laboratories in average conditions (i.e. there are some problems but overall, infrastructure and equipment work). The remaining countries (12) reported that they have infrastructure and equipment that are poorly maintained and that are not sufficient to carry out the workload. Details on the countries in each category are reported in Table 1. Please note that countries marked with (*) reported a mix of conditions.

Table 1. Average condition of soil laboratories at the country level.

Countries with soil laboratories in poor conditions	**Countries with soil laboratories in fair conditions**	**Countries with soil laboratories n good conditions**
Africa: Botswana, the Democratic Republic of Congo, Ethiopia, Gabon, Guinea-Bissau, Republic of Guinea*, Liberia, Madagascar, Malawi*, Niger*, Nigeria*, Senegal*, Sierra Leone, Somalia, South Sudan and Togo*. *Asia*: Afghanistan, Cambodia, Pakistan* and Vietnam *Eurasia:* Kyrgyzstan, Tajikistan *Latin America*: Bolivia, Cuba and Haiti. *NENA:* Iraq*, Sudan* and Tunisia*	*Africa:* Burkina Faso, Cameroon, Cape Verde, Djibouti, Eswatini, Ghana, Republic of Guinea*, Kenya, Lesotho, Malawi*, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger*, Nigeria*, Rwanda, Sao Tome and Principe, Senegal*, South Africa, Sudan, Tanzania, Togo*, Zambia, Zimbabwe. *Asia:* Bangladesh, India, Indonesia, Laos, Mongolia, Myanmar, Nepal, Pakistan*, Philippines, Sri Lanka and Thailand. *Eurasia:* Armenia, Azerbaijan, Georgia, Kazakhstan, Republic of Moldova, Russian Federation*, Ukraine* and Uzbekistan. *Europe:* Bulgaria, Denmark, Hungary, Kosovo, Latvia*, North Macedonia, Portugal*, Romania, Serbia, Slovenia and Turkey. *Latin America:* Antigua and Barbuda, Argentina, Bahamas, Barbados, Brazil, Chile, Colombia, Costa Rica*, Dominican Republic, Ecuador, El Salvador, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Trinidad and Tobago, Uruguay and Venezuela. *NENA:* Bahrain, Iran, Iraq*, Jordan, Lebanon, Morocco, Palestine, Sudan*, Syria, Tunisia* and Yemen *Pacific:* Fiji, Guam, Papua New Guinea and Samoa	*Africa:* Malawi* and Nigeria*. *Asia:* Bhutan, China, Japan, Republic of Korea and Malaysia *Eurasia:* Russian Federation* and Ukraine*. *Europe:* Austria, Belgium, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Iceland, Israel, Italy, Latvia*, Netherlands, Poland, Portugal*, Slovakia, Spain, Sweden, Switzerland, and United Kingdom. *Latin America:* Costa Rica*, Guatemala *NENA:* Kuwait and United Arab Emirates *North America:* United States *Pacific:* Australia, New Caledonia and New Zealand

Looking at the qualification of laboratory staff, the majority of countries (74) reported that their laboratory staff have a university degree but are rarely or not sufficiently trained. Therefore, one of the priorities for the soil laboratories operating in NENA, the Pacific, Eurasia and Latin America especially is the organization of staff training on a regular basis. Otherwise, 21 countries reported to be working with laboratory staff that learned by doing, and only 47 countries stated that their laboratory staff have a university degree and are trained on a regular basis. The regions in which building the capacity of laboratory staff is needed the most are Africa and Asia. On the contrary, the regions in which the qualification of laboratory staff is less of a priority are Europe and North America. Details on the countries in each category are reported in Table 2. Please note that countries marked with (*) reported a mix of conditions.

Table 2. Average qualification of soil laboratory staff at the country level.

Countries in which laboratory staff learned by doing	**Countries in which laboratory staff have a university degree but are rarely or not sufficiently trained**	**Countries in which laboratory staff have a university degree and are trained on a regular basis**
Africa: Botswana*, Cameroon*, Ethiopia, Kenya*, Liberia, Namibia, Niger and Sao Tome and Principe *Asia:* China*, Laos and Sri Lanka *Eurasia:* Russian Federation*, Tajikistan *Europe:* Austria*, Portugal* and Serbia *Latin America:* Bolivia, Brazil, Trinidad and Tobago *NENA:* Morocco* and Tunisia* *Pacific:* Guam*	*Africa:* Botswana*, Burkina Faso, Cameroon*, Cape Verde, Democratic Republic of Congo, Djibouti, Eswatini, Gabon, Ghana, Guinea-Bissau, Republic of Guinea, Kenya*, Lesotho, Madagascar, Malawi*, Mali, Mauritania, Mozambique, Nigeria*, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, South Sudan, Tanzania, Togo, Zambia and Zimbabwe* *Asia:* Afghanistan, Bhutan, Cambodia, China*, India*, Indonesia, Republic of Korea, Mongolia, Myanmar, Nepal, Pakistan, Philippines*, Thailand and Vietnam *Eurasia:* Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, The Republic of Moldova, Russian Federation*, Ukraine and Uzbekistan *Europe:* Austria*, Belgium*, Denmark, France, Hungary, Kosovo, Latvia, Poland, Portugal*, Romania, Slovenia, Spain and Turkey *Latin America:* Argentina, Bahamas, Chile, Colombia*, Costa Rica*, Dominican Republic, Ecuador, Guyana, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Uruguay and Venezuela* *NENA:* Bahrain, Iraq, Jordan, Lebanon*, Morocco*, Palestine, Sudan, Syria, Tunisia* and Yemen *Pacific:* Fiji, Guam*, New Caledonia, Papua New Guinea and Samoa	*Africa:* Malawi*, Mauritius, Nigeria* and Zimbabwe* *Asia:* Bangladesh, India*, Japan, Malaysia and the Philippines* *Eurasia:* Russian Federation* *Europe:* Austria*, Belgium*, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Iceland, Israel, Italy, Netherlands, North Macedonia, Portugal*, Slovakia, Sweden, Switzerland and the United Kingdom *Latin America:* Antigua and Barbuda, Barbados, Colombia*, Costa Rica*, Cuba, El Salvador, Guatemala, Haiti, Honduras, Jamaica and Venezuela* *NENA:* Iran, Kuwait, Lebanon* and the United Arab Emirates *North America:* United States *Pacific:* Australia and New Zealand

Figure 5 relates laboratory conditions to laboratory staff qualification in the different regions.

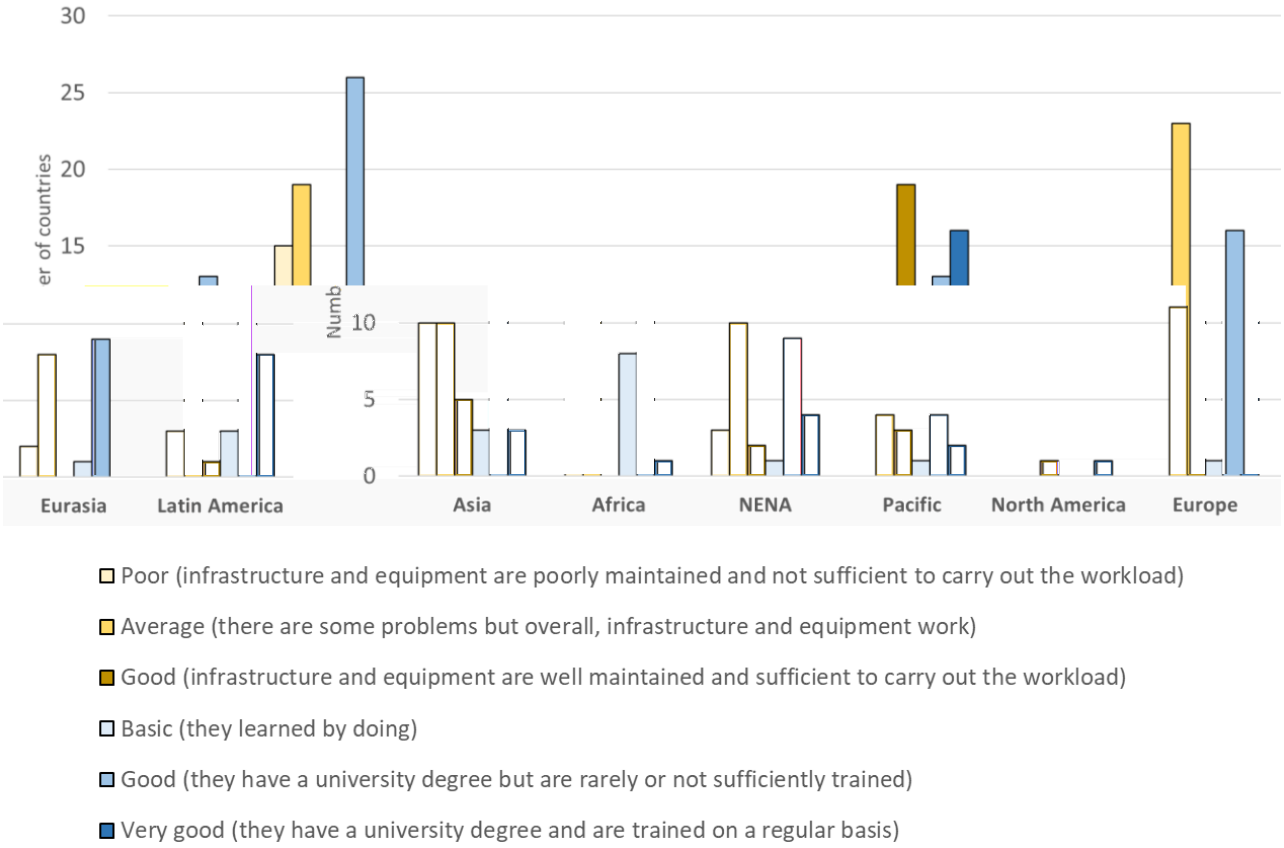


Figure 5. Laboratory conditions in terms of structure (infrastructures, equipment) and staff member qualifications on regional basis.

Colors in yellow scale stand for the average level of structure conditions, while in blue scale colors is represented the average level of staff qualification

2.3. Soil analysis

Table 3 reports the number of countries performing the main types of soil analysis (soil chemical, soil biological and soil physical analysis) within their laboratories.

- **Soil chemical analysis** refers to the analysis of nitrogen (N), phosphorous (P), potassium (K), pH, soil organic matter (SOM), soil organic carbon (SOC), cation exchange capacity (CEC), soil micronutrients, pollutants, heavy metals and fertilizer quality.
- **Soil biological analysis**
- **Soil physical analysis**

Please note that countries that have laboratories doing heavy metals analysis tests include tests for lead (Pb), zinc (Zn), iron (Fe), manganese (Mn), cadmium (Cd), chromium (Cr), copper (Cu) and nickel (Ni).

Table 3. Type soil analysis performed by laboratories at regional level (numbers indicate the number of laboratories).

	Africa	Asia	Eurasia	Europe	Latin America	NENA	North America	Pacific
Total number of countries completing the survey	35	19	10	30	27	13	1	7
Soil chemical analysis	35	19	10	30	26*	13	1	7
Soil biological analysis	12	9	5	16	6	9	1	5
Soil physical analysis	29	13	9	24	20	12	1	7

* Note: the Bahamas did not reply this question

While all countries reported to have laboratories doing soil chemical analysis, countries with a large number of laboratories doing soil physical and soil biological analysis are fewer in number.

Countries reporting not to have a large number of laboratories doing soil physical analysis are:

- *Africa*: Cape Verde, Madagascar, Mauritius, Rwanda, Senegal, Somalia
- *Asia*: Bangladesh, Cambodia, India, Myanmar, Republic of Korea, Sri Lanka
- *Eurasia*: Kazakhstan
- *Europe*: France, Israel, North Macedonia, Serbia, Spain, United Kingdom
- *Latin America*: Antigua and Barbuda, Bolivia, Chile, Jamaica, Mexico, Uruguay
- *NENA*: Jordan
- *North America*: none
- *Pacific*: none

Countries that do not have a large number of laboratories doing soil biological analysis are:

- *Africa*: Botswana, Cape Verde, Democratic Republic of Congo, Eswatini, Ethiopia, Republic of Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Mauritania, Mauritius, Mozambique, Namibia, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Sudan, Tanzania, Togo
- *Asia:* Afghanistan, Bangladesh, Bhutan, Cambodia, India, Laos, Myanmar, Nepal, Pakistan, Republic of Korea
- *Eurasia:* Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Uzbekistan
- *Europe:* Belgium, Croatia, Denmark, France, Greece, Iceland, Kosovo, Latvia, North Macedonia, Romania, Serbia, Spain, Turkey, United Kingdom
- *Latin America:* Antigua and Barbuda, Barbados, Bolivia, Brazil, Chile, Costa Rica, Dominican Republic, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Saint Lucia, Trinidad and Tobago, Uruguay
- *NENA:* Kuwait, Syria, Tunisia, Yemen
- *North America:* none
  Pacific: Guam, Papua New Guinea.

The use of technologies like spectroscopy was also investigated. Almost half of the surveyed countries (48 percent) use soil spectroscopy as an alternative to wet-chemistry analysis. The highest number of soil laboratories using this technology was reported in Europe and North America. Still, laboratories using soil

spectroscopy techniques are at different stages of adoption: some laboratories are new to its use, others have long-time experience with such technology, and others would like to enlarge its use. Otherwise, 46 percent of surveyed countries declared not to use this technology. The remaining 6 percent of countries were unsure about the use of spectroscopy in their national soil laboratories.

Looking at the answers provided by individual laboratories, it is interesting to notice that 70 percent of the responding laboratories do not use soil spectroscopy techniques but would like to approach this method (see *figure 6*). The regions showing the greatest interest in the adoption of this technology are Africa and NENA, followed by Eurasia, Asia and Latin America. Only twelve responding laboratories out of the total expressed no interest in using soil spectroscopy.

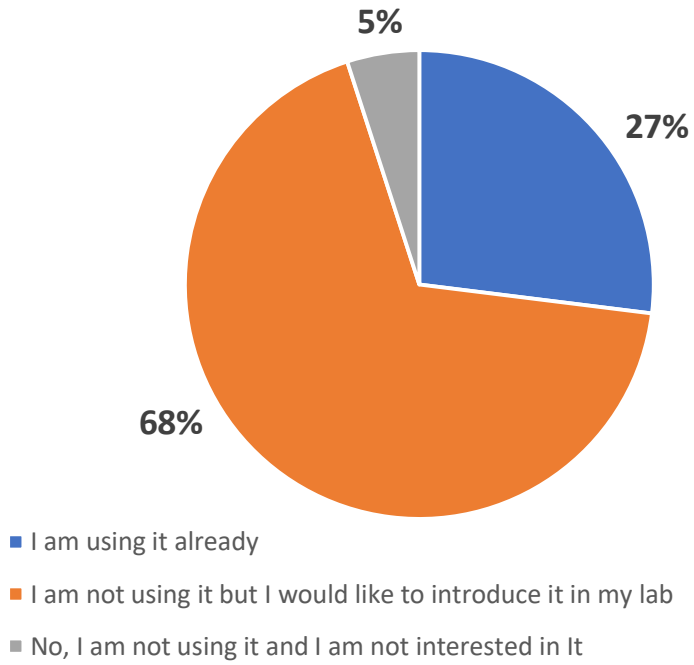


Figure 6. Use of spectroscopy in the surveyed laboratories.

The use of common standards in soil analysis is of main concern to GLOSOLAN because of its impact on the comparability of laboratory results. Sixty-two percent of countries declared that they have soil laboratories following international standards like those of the International Standard Organization (ISO) or national standards. Africa and NENA were the only regions in which the use of international standards is not a common practice.

The same scenario applies to the use of quality control procedures (see *figure 7)*. Seventy-two percent of countries declared that they have soil laboratories that are adopting or have adopted quality control procedures. However, this percentage is lower in the African and NENA regions. The regions where quality control procedures are implemented the most are North America, Latin America, Europe, the Pacific, followed by Asia and Eurasia.

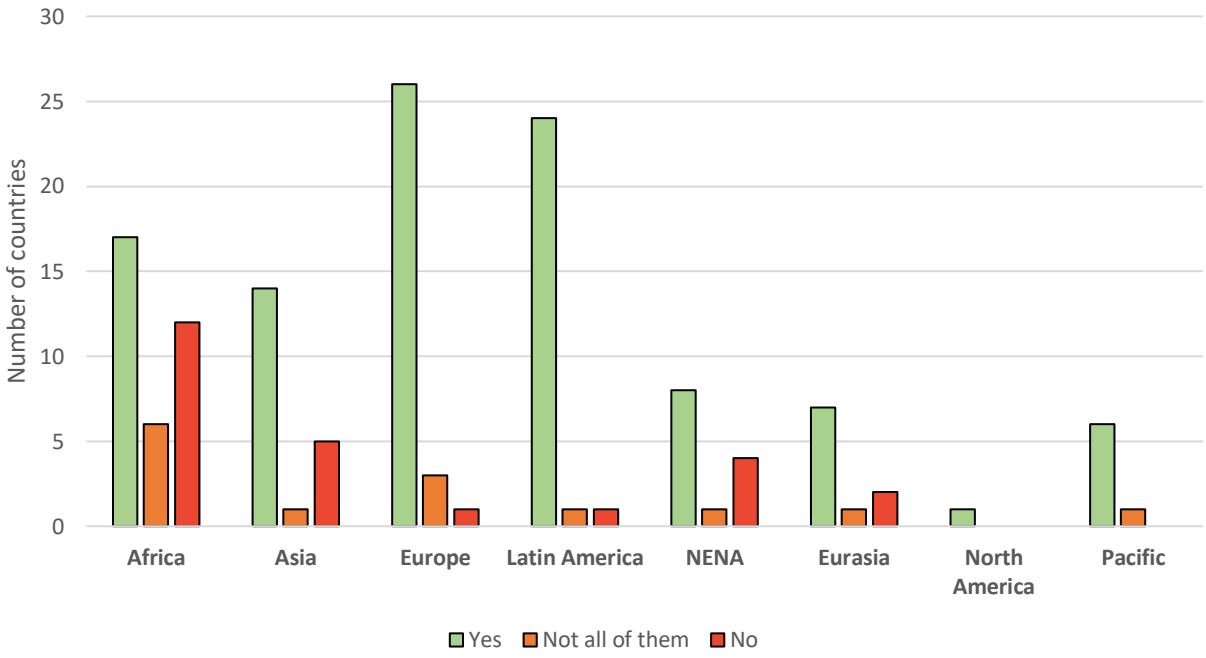


Figure 7. Graph showing the number of countries where laboratories have quality control procedures in place.

"Yes" means all laboratories in the country perform QC assessment,
while "No" stands for those countries where laboratory do not perform QC

2.4. Laboratory needs

In the majority of cases, the technical assistance offered by manufacturers to laboratories after instrumentation purchasing is inadequate. In addition, the majority of countries reported problems with the purchase of consumables and a lack of laboratory staff with experience on the maintenance of laboratory equipment. Additionally, remarks were made on the absence of assistance for damaged instruments (see *figure 8*).

While the majority of countries in Europe (25 out of 30) receive sufficient technical assistance and can easily purchase consumables, the opposite is true in Africa, the Pacific and NENA. In these three regions, better technical assistance is required not only for repairing damaged equipment but also for training laboratory staff on instruments use and maintenance. Note that in Europe, countries that require a better technical assistance are Greece and Romania. Portugal, Latvia and Turkey had laboratories providing conflicting answers (both sufficient and insufficient). In Asia, Eurasia and Latin America there is a balance between countries declaring to have laboratories that receive sufficient technical assistance and those declaring that they do not.

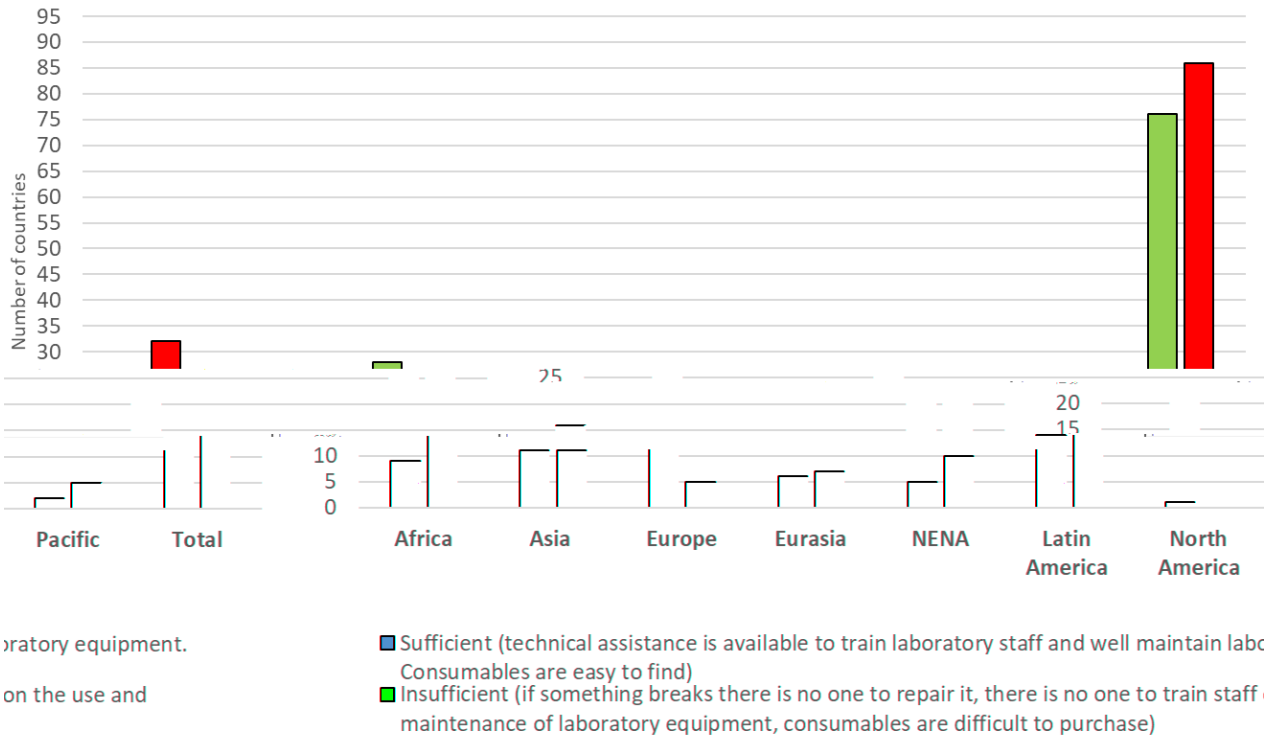


Figure 8. Technical assistance offered by manufacturers in the different countries, on regional basis.

In terms of general needs, laboratories stressed (i) the need for laboratory staff to receive continuous training, (ii) the lack of expertise to properly maintain and repair laboratory equipment (and sometimes also in purchasing new instruments and spare parts), and (iii) the demand for harmonizing soil analysis procedures and validation and calibration methods (see *figure 9*).

The development of better waste management and disposal policies (both at local and global scales) were also perceived as strongly needed. The sourcing of consumables of sufficient quality also represents an obstacle to the proper functioning of soil laboratories. This last point needs to be brought to the attention of manufacturers and distributors.

Other concerns include (iv) the request for a better quality control management, encompassing proficiency testing and the availability of reference soil samples as well as the possibility for the laboratory to be accredited, (v) the difficulty in improving laboratory facilities, (vi) the need for more internships and international exchange opportunities, (vii) the need to develop an integrated soil laboratory information system aiming to facilitate the establishment of national soil laboratory networks, (viii) the need to raise the awareness of local institutions, which is pivotal to the national mobilization of financial resources, and (ix) the difference in price of the analysis performed by different laboratories (public, private, research centers, etc.) in a same country, which can result in market unfairness.

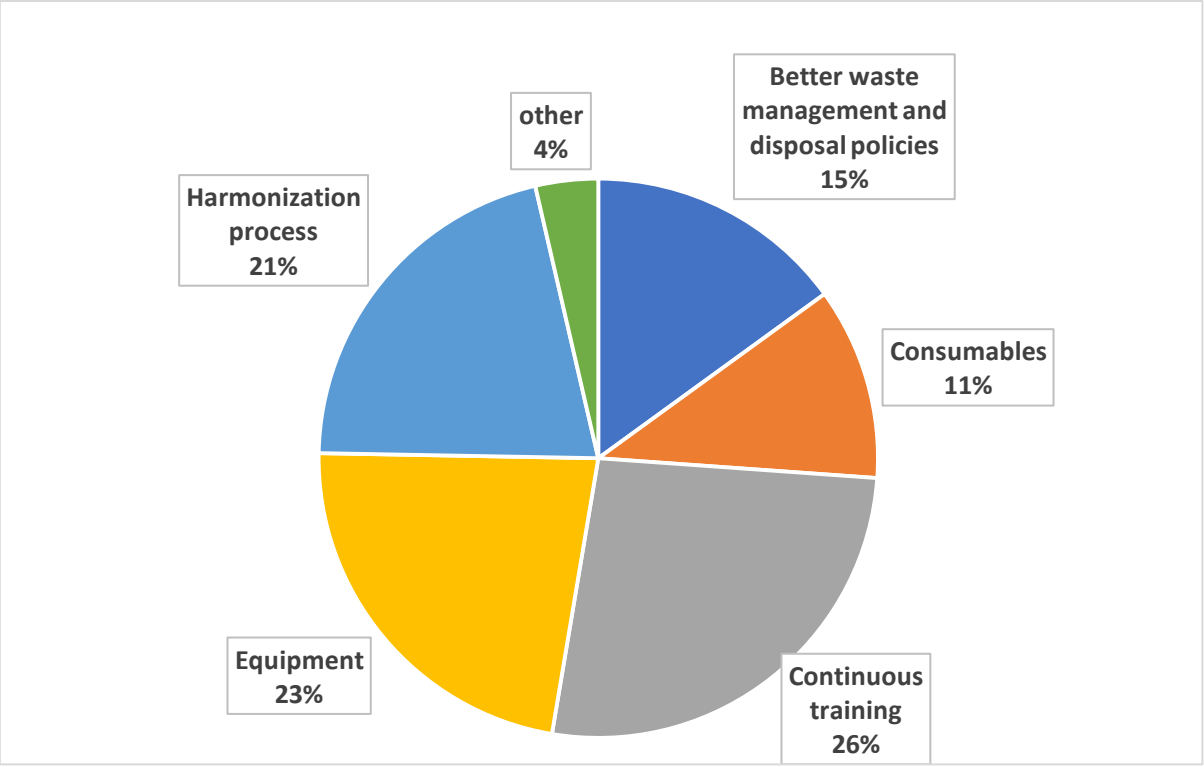


Figure 9. Main needs of the surveyed laboratories. Results are expressed as percentages of the total amount of responses.

3. Conclusions

The specific challenges faced by soil laboratories differ across the regions.

In the **African region**, the number of soil laboratories is the lowest of all the regions surveyed. The majority of laboratories available in the region are public and struggle to cover the country demand in terms of analytical services. Soil laboratories reported a strong need to get their staff trained, to get quality instruments and consumables, and to have better technical assistance services for the maintenance of analytical instruments. Moreover, the majority of laboratories are not meeting international standards and do not implement quality control procedures.

In **Asia,** soil laboratories require the organization of periodic training for laboratory staff on the maintenance of laboratory equipment.

Soil laboratories in the **Eurasian region** require their staff to be trained on a regular basis and to receive better technical assistance for the use and maintenance of laboratory equipment. Indeed, manufacturers and distributors were reported to provide limited after-sale services. Ultimately, countries stressed the poor or average conditions of their laboratory infrastructures that need to be improved.

Overall soil laboratories in **Europe** have good infrastructures, receive sufficient assistance from manufacturers and distributors, do not struggle to source consumable, and can count on highly qualified staff. However, a few countries reported to still have issue with meeting the country demand for analytical services. The quality of the analysis is guaranteed by a widespread adoption of quality control procedures and the international standards.

In **Latin America**, soil laboratories require the organization of periodic training events for laboratory staff and investments to improve laboratories' infrastructure and to purchase good quality equipment.

Soil laboratories operating in **NENA** demand better technical assistance by manufacturers and distributors, which may result also in an upgrade of laboratory conditions. This is needed to improve the national analytical capacity and to face the country demand.

In **North America,** the majority of soil laboratories operate in the private sector, are in good conditions and meet the country demand for analytical services. However, the need for regular trainings and harmonization of laboratories' procedures was stressed. Please note that the only reply to the survey was provided by United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), National Soil Survey Center (NSSC), Kellogg Soil Survey Laboratory (KSSL), which is the standard -setting facility for the US National Cooperative Soil Survey.

In the **Pacific region,** the distance between countries play a big role in soil laboratories' capacities and needs. In this regard, soil laboratories struggle to receive appropriate technical assistance by manufacturers and distributors, and to purchase and receive consumables in a timely manner. Furthermore, the majority of countries in the region count on staff that is not sufficiently and regularly trained on the use and maintenance of laboratory equipment.

In general terms, all regions stressed the need to have their staff regularly trained and to receive better after-sale services on equipment. The harmonization, validation and calibration of soil analysis methods and the use of common standards was stressed as needed as well as the development of better waste management and disposal policies. The establishment of internship and international exchange programmes was requested to promote knowledge and experience sharing on soil laboratories. This also links to the interest of laboratories to begin to use technologies like soil spectroscopy. Looking at the number of laboratories doing soil chemical, physical and biological analysis, the need for increasing the number of laboratories analyzing soil physical and biological parameters was clear. Indeed, the practice of sustainable soil management relies on the integrated analysis of soil chemical, physical and biological parameters.

GLOSOLAN is already active in addressing the majority of the challenges and needs reported above. Thanks to the contribution of its donors, partners and registered laboratories, GLOSOLAN is already active in:

- Harmonizing standard operating procedures (SOPs). Great attention was paid to harmonize SOPs for soil chemical analysis, as these are the most practiced by soil laboratories. However, in 2020 will start working on the harmonization of SOPs for soil physical and soil biological analyses;
- Organizing regional and global inter-laboratory comparisons, which are at the basis of GLOSOLAN activities on the procurement of laboratory equipment;
- Facilitating the global exchange of soil samples through the development of the Soil Import Legislation Database (SIMPLE);
- Organizing regional training events on topics including the procurement, use and maintenance of laboratory equipment, and health and safety. National training events are organized depending on the availability of financial resources;
- Promoting regional discussions and experience exchange through the establishment of Regional Soil Laboratory Networks;
- Promoting national discussions and experience exchange through the establishment of National Soil Laboratory Networks.

However, much more needs to be done in terms of:

- Training;
- Improvement of soil laboratory facilities;
- Provision of equipment for improving laboratory capacities or enlarging the set of analysis performed by each laboratory;
- Health and safety systems, which are still lacking in many laboratories worldwide;

- Disposal and management of laboratory waste;
- Procurement of good quality consumables;
- Interpretation of laboratory results;
- Establishment of exchange programmes and a buddy system at different levels (national, regional and global);
- Support for nationally driven activities, which link back to the establishment of the National Soil Laboratory Networks and to the organization of national inter-laboratory comparisons.

To address these points of attention, GLOSOLAN needs the support of:

- soil laboratories that should be responsive to GLOSOLAN requests for information, and active in implementing GLOSOLAN standards and recommendations;
- national governments that should be kept informed on national, regional and global activities implemented under GLOSOLAN, in order to react as needed. Government support is especially needed for mobilizing financial resources at the national level, and for improving policy frameworks on waste management and disposal from laboratories. National governments can define minimum quality standards and minimum prices in soil analysis that can help reducing unfair competition among laboratories. Cooperation with national governments is critical to improve the conditions of public laboratories especially;
- existing networks to avoid duplication of efforts and better allocate the financial resources available on soil laboratories;
- experts on soil laboratories to train laboratories and networks in need as appropriate;
- manufacturers and distributors to provide better after-sale services and training on equipment use and maintenance to soil laboratories.

Ultimately, GLOSOLAN needs the support of donors to keep on implementing global, regional and national activities.

Annex I. List of survey participants

Africa

Botswana - Environmental Lab, University of Botswana (ORI)

Botswana - Soil and Plant Analytical Laboratory

Burkina Faso - Bureau National des Sols (BUNASOLS)

Cameroon - Laboratoire d'Analyses des Sols, Plantes, Eaux et Engrais (LASPEE)

Cameroon - National Laboratory for Diagnosis and Quality Control of Agricultural Products and Inputs

Cameroon - Soil, Water, Plant and Fertilizer Analytical Services Laboratory

Cape Verde - Laboratório de Análises de Solos, Águas e Plantas (LASAP)

Democratic Republic of Congo - Laboratoire des Sols INERA Mvuazi

Djibouti - Laboratory Pedology

Eswatini - Soil Testing Unit

Ethiopia - Holeta Agricultural Research Center Soil Laboratory

Gabon - Laboratoire de Pédologie IRAF

Ghana - CSIR-SARI, Environmental Analytical Laboratory (CSIR-SARI, EAL)

Ghana - Laboratory Analytical Service- Accra Centre (SRI-LAS)

Ghana - Soil Research Institute Analytical Services Laboratory (SRI-LAB)

Ghana - Soil Science Laboratory, KNUST

Guinea-Bissau - Laboratório Nacional de Solos, Águas e Plantas

Kenya - National Agricultural Research Laboratories

Kenya - Universtiy of Eldoret

Lesotho - Soils Lab

Liberia - Ministry of Agriculture

Madagascar - Laboratoire des RadioIsotopes

Malawi - Agricultural Research and Extension Trust (ARET)

Malawi - Agrilab, Farming and Engineering Services Limited

Malawi - Soil and Plant Analytical Research Laboratory

Mali - LPCM

Mali - Soil-Water-Plante Laboratory (LSEP)

Mauritius - Agricultral Chemistry Laboratory, MSIRI - MCIA

Mauritania - Laboratoire de Pédologie et Fertilisation

Mozambique - Laboratorio Regional de Analises de Solos e Planta (LRASP), Nampula Province

Namibia - Analytical Services and Product Development (Soil Section)

Niger - Laboratoire Sol, Eau, Plante et Engrais (LASEVE)

Niger - Sols et dynamique de surface

Nigeria - Fecolart Owerri, Imo State

Nigeria - IITA Analytical Service Laboratory, Ibadan

Nigeria - National Soil Testing Laboratory Complex

Nigeria - National Soil, Water and Fertilizer Lab, Kaduna

Nigeria - Phosphorus Lab

Nigeria - Soil Science Lab FUD (Federal University Dutse)

Republic of Guinea - Laboratoire Central de l'Institut de Recherche Agronomique de Guinée(IRAG)

Republic of Guinea - Laboratoire National d'Analyse de Sols, des Engrais, des Végétaux et Eaux du Services National des Sols (SENASOL)

Rwanda - Agricultural Chemistry Laboratory, MSRI, MCIA

Rwanda - Analytical Lab for Soil and Plant

Sao Tome and Principe - Laboratory of the CIAT-STP (LabCIAT)

Senegal - Institut de Technologie Nucléaire Appliquée (ITNA)

Senegal - Research Center in Ecotoxicology and Environmental Safety (CERES Locustox)

Sierra Leone - Njala University Quality Control Laboratory

Somalia - SomSoil

South Africa - Agricultural research Council-Soil, Climate and Water

South Sudan - University of Juba

Tanzania - TARI Mlingano Soil Laboratory

Togo - Laboratoire d'Analyse des Sols et des Végétaux de l'Ecole Supérieure d'Agronomie de l'Université de Lomé

Togo - Laboratoire de Sols, Eaux, Végétaux et Engrais, Institut Togolais de Recherche Agronomique

Zambia - National Soil and Fertilizer Laboratory

Zambia - Plant & Soil Chemistry Laboratory, Zambia Agriculture Research Institute (ZARI)

Zambia - Soil Science Laboratory, University of Zambia

Zimbabwe - Fertilizers Seed and Grain (FSG)

Zimbabwe - GNK Laboratories (Zimlabs)

Zimbabwe - Soil Science & Agricultural Engineering, University of Zimbabwe

Zimbabwe - Zimbabwe Sugar Association Experiment Station

Asia

Afghanistan - Kohkaran Soil lab (KSL)

Afghanistan - Sheshambagh Research Soil Analysés Laboratory (SRSSAL)

Afghanistan - Soil Research Laboratory of Soil Research Directorate (SRD)

Bangladesh - Central Laboratory, Soil Resource Development Institute (SRDI)

Bhutan - Soil and Plant Analytical Laboratory (SPAL)

Cambodia - Soil and Plant Analysis Laboratory, Royal University of Agriculture

China - Institute of Agricultural Resources and Regional Planning (IARRP), Chinese Academy of Agricultural Sciences (CAAS)

China - Institute of Soil Fertilizer and Environmental Resources, Heilongjiang Academy of Agricultural Sciences (SFI, HAAS)

India - Charles Renard Analytical Laboratory (CRAL), ICRISAT

India - Indian Institute of Soil Science (ICAR)

Indonesia - Laboratorium Pengujian Balai Penelitian Tanah

Japan - Institute for Agro-Environmental Sciences, NARO

Laos - Soil, Fertilizer and Plant Analysis Unit

Malaysia - Soil Laboratory Unit, DOA Kuala Lumpur

Mongolia - Integrated agricultural laboratory

Mongolia - Soil-Agrochemistry Laboratory of IPAS

Mongolia - Soil and Agrochemistry Laboratory, Mongolian University of Life Science

Mongolia - Soil Laboratory of the Institute of Geography and Geoecology, Mongolian Academy of Sciences

Myanmar - Land Use Laboratory of the Agriculture Department in Mandalay, Upper Myanmar (LUD Lab, MDY)

Myanmar - Land Use Laboratory of the Agriculture Department in Yangon, Lower Myanmar (LUD Lab, YGN)

Myanmar - Soil and Plant Analysis Laboratory (SPAL and IWQL - DAR)

Nepal - Central Agricultural Laboratory

Nepal - Soil Science Division, NARC, Khumaltar

Pakistan - FFC Soil Testing Labs

Pakistan - Soil and Environmental Sciences, University of Agriculture Peshawar

Philippines - Central Analytical Laboratory, University of Southern Mindanao Agricultural Research Center (USMARC-CL)

Philippines - CRL Environmental Corporation

Philippines - Department of Agriculture - Regional Soils Laboratory 4A

Philippines - Department of Agriculture - Regional Soils Laboratory CAR

Philippines - Department of Agriculture - Regional Soils Laboratory RFO I

Philippines - Department of Agriculture - Regional Soils Laboratory RFO II

Philippines - Department of Agriculture - Regional Soils Laboratory RFO III

Philippines - Department of Agriculture - Regional Soils Laboratory RFO VII

Philippines - Department of Agriculture - Regional Soils Laboratory RFO VIII

Philippines - Department of Agriculture - Regional Soils Laboratory RFO IX

Philippines - Department of Agriculture - Regional Soils Laboratory RFO XI

Philippines - Department of Agriculture - Regional Soils Laboratory RFO XII

Philippines - Department of Agriculture - Regional Soils Laboratory RFO Mimaropa

Philippines - Laboratory Services Division - Bureau of Soils and Water Management (BSWM)

Philippines - Soil and Water Research Laboratory, Central Bicol State University of Agriculture (CBSUA)

Philippines - University of the Philippines Los Baños (UPLB)

Republic of Korea - Soil analysis laboratory in Soil and Fertilizer Division

Sri Lanka - Central Soil and Fertilizer Testing Laboratory, Department of Agriculture

Thailand - Laboratory of Soil and Plant Analysis - Department of Soil Science, Kasetsart University (KU)

Thailand - Laboratory of Soil Science, Department of Plant and Soil Sciences, Chiang Mai University

Thailand - Laboratory of Soil Science, Department of Plant Production Technology, King Mongkut's Institute of Technology Ladkrabang (Soil Science, KMITL)

Thailand - Office of Science for Land Development Department

Thailand - The Center for Scientific and Technological Equipment, Walailak University

Vietnam - Central Analytical Laboratory – Soils and Fertilizers Research Institute

Eurasia

Armenia - Agricultural Services Centre

Azerbaijan - Soil Ecology International Laboratory ANAS Institute of Soil Science and Agrochemistry

Georgia - Laboratory of Soil Fertility Research Service, Scientific-Research Centre of Agriculture

Kazakhstan - Analytical Complex International Lab (ACILab), Research Centre of Ecology and Environment of Central Asia of Almaty

Kyrgyzstan - Soil laboratory of the Republican Soil-Agrochemical Station (RPAS)

Republic of Moldova - The Laboratory of Soil Microbiology, Institute of Microbiology and Biotechnology

Russian Federation - Ecoanalytical laboratory of the Institute of Biology of Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences

Russian Federation - Testing Center of Soil Science Faculty of the Moscow State University named after MV Lomonosov

Tajikistan - Laboratory of Soil Research Institute, Tajik Academy of Agricultural Science (TAAS)

Ukraine - Laboratory of Chemical and Biological Factors (LCBF)

Ukraine - Laboratory of Instrumental Soil Research Methods (NSC ISSAR, Kharkiv)

Ukraine - Ukrainian Laboratory of Quality and Safety of Agricultural Products of the National University of Life and Environmental Sciences of Ukraine

Uzbekistan - Soil Chemistry and Soil Biology Laboratory (SL-Uzb)

Uzbekistan - Soil Composition and Repository, Quality Analysis Center - State Unitary Company

Europe

Austria - Austrian Agency for Health and Food Safety (AGES)

Austria - University of Natural Resources and Life Sciences, Institute for Soil Research (IBF - BOKU)

Belgium - Axe Echanges Eau-Sol-Plantes, Liege University (GxABT-EESP)

Belgium - Soil Physics and Mechanics, Gembloux Agro-Bio Tech

Bulgaria - Nikola Poushkarov ISSAPP

Czech Republic - Central Institute for Supervising and Testing in Agriculture (UKZUZ)

Croatia - Euroinspekt Croatiakontrola d.o.o.

Denmark - AGRO University Laboratory

Estonia - Agricultural Research Centre

Estonia - Estonian Environmental Research Centre

Finland - Natural Resources Institute Finland

France - Eco&Sols

France - Laboratoire d'Analyses des Sols (LAS), Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE)

Germany - Thünen Agricultural Soil Inventory Laboratory

Greece - Interbalkan Environment Center

Hungary - Food Chain Safety Centre Non-profit Ltd., Soil Conservatory Laboratory, Velence

Iceland - Soil Conservation Service of Iceland Soil Lab (SCSISL)

Israel - Remote Sensing Laboratory Tel Aviv University (RSL-TAU)

Italy - AGRI-BIO-ECO Laboratori Riuniti SRL

Kosovo - Kosovo Institute of Agriculture

Latvia - Agrochemical Laboratory, State Plant Protection Service

Latvia - Laboratory of Forest Environment, Latvian State Forest Research Institute "Silava"

Netherlands - AgroCares - Golden Standard laboratory

Netherlands - Soil Hydro-Physics laboratory, Wageningen University

Poland - Institute of Soil Science and Plant Cultivation, State Research Institute

Poland - Laboratory of Biogeochemistry and Environmental Protection, Biological and Chemical Research Centre University of Warsaw

Portugal - A2 Analises Quimicas, LDA

Portugal - Laboratório de Solos e Fertilidade da Escola Superior Agrária de Castelo Branco (Lab-Solos/ESACB)

Portugal - Laboratório de Solos UTAD

Portugal - Laboratorio Quimico Agricola - University of Evora

Portugal - Laboratorio Químico Agricola Rebelo da Silva (INIAV/SAFSV/LQARS), INIAV/Laboratory of Soil (INIAV/LS)

Republic of North Macedonia - Laboratory for Quality Control of Soil, Water, Fertilizers and Plant Material, University Kliment Ohridski

Republic of North Macedonia - Laboratory for Soil Quality, Fertilizers and Plants, University Ss. Cyril and Methodius

Romania - Department of Analytical Services

Romania - Physical and Chemical Analysis Laboratory, RISSA

Serbia - Food Safety and Technology Laboratories

Serbia - Laboratory for Soil and Agroecology, Institute of Field and Vegetable Crops

Slovakia - Department of Laboratory Methods of Soil Science and Conservation Research Institute

Slovenia - Institute for Chemistry, Ecology, Measurements and Analytics (IKEMA d.o.o.)

Spain - Eurofins Agroambiental (Lleida)

Sweden - Department of Soils and Environment, Swedish University of Agricultural Sciences

Switzerland - Kompetenzzentrum Boden (KOBO) - Centre de compétences sur les sols (CCSols)

Turkey - Soil and Fertilizer Laboratory - Ankara University, Turkey (SOFREL TR)

Turkey - Soil Fertilizer and Water Resources Central Research Institute

United Kingdom - Rothamsted Research Analytical Chemistry Unit

Latin America and the Caribbean

Antigua and Barbuda - Department of Analytical Services

Argentina - Laboratorio de Suelo y Agua (RILSAV-EEA ANGUIL)

Argentina - Laboratorio de Suelo y Agua (RILSAV-EEA H. ASCASUBI)

Argentina - Laboratorio de Suelo y Agua (RILSAV-EEA INTA Bordenave)

Argentina - Laboratorio de Suelos y Aguas (RILSAV-EEA ALTO VALLE)

Bahamas - Food Safety and Technology Laboratories

Barbados - Government Analytical Services (GAS)

Bolivia - Laboratorio de Suelo, Agua y Planta del Centro de Investigación Agrícola Tropical

Brazil - Laboratorio de Analise de Agua, Solo e Planta (Embrapa/LASP)

Chile - Laboratorio de Análisis Químico de Suelos y Plantas (UdeC)

Colombia - Laboratorio Nacional de Suelos, Instituto Geográfico Agustín Codazzi (IGAC)

Colombia - Universidad de La Salle

Costa Rica - Laboratorio de Suelos y Foliares (LSF, CIA-UCR)

Cuba - Laboratorio de Suelos UCTB Camagüey

Dominican Republic - Laboratorio de Suelos (LABOAGRO UASD)

Ecuador - Laboratorio de Suelos, Foliares y Aguas (AGROCALIDAD)

El Salvador - Centro Nacional de Tecnología Agropecuaria y Forestal (CENTA)

Guatemala - Laboratorio de Suelo, Planta y Agua "Salvador Castillo Orellana"

Guyana - Soil Chemical Services Laboratory of the Soil Management and Farm Mechanization (SM&FM), Department of the National Agricultural Research and Extension Institute (NAREI)

Haiti - Laboratoire National de Sols (LNS)

Honduras - Laboratorio Químico Agrícola & Residuos de Pesticidas de la Fundación Hondureña de Investigación Agrícola (FHIA)

Jamaica - Soil Health, Water and Plant Tissue Laboratory

Mexico - Laboratorio Agroindustrial, Suelo, Planta Y Agua (LASPA)

Nicaragua - Laboratorio de Suelos y Agua "Comandante Fidel Castro Ruz"

Panama - Laboratorio de Fertilidad de Suelo y Agua del IDIAP

Paraguay - Laboratorio de Suelos de la Facultad de Ciencias Agrarias, Universidad Nacional de Asunción

Peru - Laboratorio de Análisis de Suelos, Plantas, Aguas y Fertilizantes de la Universiddad Nacional Agraria La Molina (LASPAF-UNALM)

Peru - Laboratorio de Quimica Agricola, Valle Grande

Saint Lucia - National Diagnostic Facility

Trinidad and Tobago - Soil & Analytical Services Laboratory (ASU)

Uruguay - Laboratorio de Suelos y Aguas de la Dirección General de Recursos Naturales - MGAP

Venezuela - Laboratorio de Ecología de Suelos, Ambiente y Agricultura

Venezuela - Unidad de Servicio de Análisis de Suelo-Agua-Planta del Centro Nacional de Investigaciones Agropecuarias (UNILAB-CENIAP)

Near East and North Africa (NENA)

Bahrain - Soil & Fertilizers Laboratory

Iran - Soil and Water Research Institute Laboratory

Iraq - Chemistry Laboratory

Iraq - Soil and Water Chemistry Laboratory

Iraq - Soil Chemistry Laboratory

Iraq - Soil Fertility and Fertilizers Laboratory

Iraq - Soil Physics and Water Resources Laboratory

Jordan - Soil Laboratory

Kuwait - Soil Chemistry and Physics Laboratories

Lebanon - Soil Characterization Lab, AUB

Lebanon - Soil, Fertilizer and Plants Lab, Lebanese Agricultural Research Institute (LARI)

Morocco - Laboratory of Pedology of DSEB ENFI

Morocco - Laboratory of Soil, Water and Plant Analysis (Lab-URECRN), Rabat

Morocco - Soil, Plant, and Water Laboratory, Agropolis Meknes, National Institute of Agronomic Research

Morocco - Soil, Water and Plant Analysis Laboratory of Research Unit Al Hoceima, CRRAT/Morocco

Palestine - Nablus central laboratory

Palestine - Testing Labs Center, Birzeit University

Sudan - Land Use, Conservation and production Administration Central Laboratory, Natural Resources

Sudan - Soil Analysis Laboratories Unit (SALU)

Syria - As-Suwayda Lab (ANRR-lab4)

Syria - Damascus LAB (ANRR-lab1)

Syria - Hama Lab (ANRR-lab3)

Syria - Homs Lab (ANRR-lab6)

Tunisia - Central Laboratory for Soil Analysis (LCAS)

Tunisia - Laboratoire de Recherche Valorisation des Eaux Non Conventionnelles, Institut National de Recherches en Génie Rural, Eaux et Forêts (INRGREF)

United Arab Emirates - Abu Dhabi Environment Agency

United Arab Emirates - Central Testing Laboratory

Yemen - Soil, Water and Plant Laboratory of Renewable Natural Resources Research Center (RNRRC) at the Agricultural Research and Extension Authority (AREA)

North America

United States of America - Kellogg Soil Survey Laboratory (USDA-NRCS-NSSC)

Pacific

Australia - DES Chemistry Centre

Fiji - Soil Science Lab, FNU, Koronivia

Fiji - Soil Science Lab, Fiji National University

Fiji - Sugar Research Institute of Fiji

Fiji - Analytical Laboratory, The Institute of Applied Sciences

Guam - Soil Science Labs, University of Guam

New Caledonia - Laboratoire des Moyens Analytiques (LAMA)

New Zealand - Environmental Chemistry Laboratory, Manaaki Whenua, Landcare Research

Papua New Guinea - National Agriculture Research Institute Prof. Kola Chemistry Laboratory

Samoa - Scientific Research Organization of Samoa

Samoa - USP-SAFT Soil Laboratory

Annex II. Global assessment on laboratory capacities and needs

By completing this survey, you will help GLOSOLAN to get a better understanding of soil analysis capacities and laboratory needs worldwide. Ultimately, **your inputs will help re-fining the GLOSOLAN work plan in terms of activities, budget allocation and provision of country specific political support.** The information you will provide will be treated as confidential by the Global Soil Partnership of FAO.

This survey will take approximately 5 minutes to complete.

Thanks in advance for your contribution!

General information

Name _ _____
Last name _____
Laboratory name _____
Country _____

Question	***Answer*** *(please complete)*
1. How many soil laboratories exist in your country? How many public/private?	
2. On average, how would you define the conditions of laboratories in your country?	*Please, click on the box to validate your answer* ☐ Poor (infrastructure and equipment are poorly maintained and not sufficient to carry out the workload) ☐ Average (there are some problems but overall, infrastructure and equipment work) ☐ Good (infrastructure and equipment are well maintained and sufficient to carry out the workload)
3. On average, how would you define the qualification of laboratory staff in your country?	☐ Basic (they learned by doing) ☐ Good (they have a university degree but are rarely or not sufficiently trained) ☐ Very good (they have a university degree and are trained on a regular basis)
4. Can you classify the type of services provided by the laboratories in your country?	☐ Soil chemical analysis: a) standard soil fertility analysis (NPK, pH, SOM/SOC, CEC); b) standard

Question	***Answer** (please complete)*
	soil fertility plus micronutrients; c) standard soil fertility analysis, micronutrients and pollutants (heavy metals); d) Fertilizer quality assessment ☐ Soil physics analysis ☐ Soil biological analysis
5. Are the available soil laboratory services (analytical capacity) enough to cover the country's demand?	☐ Yes ☐ No
6. Is any of the laboratories in your country including soil spectroscopy as an alternative to wet-chemistry? If yes, what is the name of the laboratory?	
7. Are you using or would like to use soil spectroscopy in your laboratory?	☐ Yes, I am using it already ☐ I am not using it but I would like to introduce it in my lab ☐ No, I am not using it and I am not interested in It
8. How many laboratories in your country are associated to international standards like ISO?	
9. Are the laboratories in your country having a quality control process?	☐ Yes ☐ No
10. On average, how would you classify technical assistance services to the laboratories in your country?	☐ Insufficient (if something breaks there is no one to repair it, there is no one to train staff on the use and maintenance of laboratory equipment, consumables are difficult to purchase) ☐ Sufficient (technical assistance is available to train laboratory staff and well maintain laboratory equipment. Consumables are easy to find)
11. What is the main need of the soil laboratories in your country?	☐ Continuous training ☐ Harmonization process ☐ Equipment ☐ Consumables ☐ Better waste management policies ☐ Other, please specify _____

GLOBAL SOIL PARTNERSHIP

The Global Soil Partnership (GSP) is a globally recognized mechanism established in 2012. Our mission is to position soils in the Global Agenda through collective action. Our key objectives are to promote Sustainable Soil Management (SSM) and improve soil governance to guarantee healthy and productive soils, and support the provision of essential ecosystem services towards food security and improved nutrition, climate change adaptation and mitigation, and sustainable development.

GLOSOLAN
GLOBAL SOIL LABORATORY NETWORK

GLOSOLAN is a Global Soil Laboratory Network which aims to harmonize soil analysis methods and data so that soil information is comparable and interpretable across laboratories, countries and regions. Established in 2017, it facilitates networking and capacity development through cooperation and information sharing between soil laboratories with different levels of experience. Joining GLOSOLAN is a unique opportunity to invest in quality soil laboratory data for a sustainable and food secure world.

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