

Evaluation of National Proficiency Testing (Pt) Provision in The Scheme of Soil Analysis on PH, Organic Carbon, Total Nitrogen and Available Phosphorus Based on the Same Soil Sample Exchange in Ethiopia

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Abstract

Proficiency testing (PT) is to monitor the quality of their analytical results, demonstrating analytical competence, developing and training analysts, and the validation of methods and instruments as stipulated in ISO/IEC 17025 in Ethiopia. Soil Samples were collected from agricultural fields representing a homogeneous soil type. The OC, TN, available P and PH were done in fifteen soil laboratories of EIAR & regional centers participated in the PT organized for 2022. The result was evaluated using Z score.

Keywords: Homogeneous, ISO/IEC and Proficiency Testing,

Introduction

Soil and agronomic studies have been conducted in Ethiopia since the 1950s. A great deal of work has been conducted related to crop response to fertilizer applications and soil survey and mapping. However, the data collected from the studies are scattered across different individuals and organizations and exist in diverse formats. As a result, most of the data are difficult to access and lack standards or are incomplete, which diminishes their utility. This resulted in duplication of effort and wasting of resources to collect redundant data. Those research technologies were released based on data collected from field and laboratory experiments. The soil laboratories are fundamental to such agricultural research endeavors, involving: analysis of soils as a basis for soil characterization and classification, identifying plant nutrient constraints, and establishing criteria for fertilizer application and efficient nutrient use, along with water, plant, and fertilizer analysis. Decision-making by policymakers, farmers, and researchers depends on reliable data on soils, water, and crops. However, a study conducted in 2016 on the status of Ethiopian soil laboratory infrastructure indicated that the data collected (in the chain of soil sampling to laboratory output) are not reliable enough for decision-making purposes [1]. Accordingly, the study emphasized the need to improve the output of Ethiopian soil, plant, and water laboratories and suggested strategies for them to fully reach their potential.

The findings of the study cast a shadow over the quality of the legacy data and data being collected and/or analyzed by the Ethiopian public and private laboratory infrastructure. Therefore, besides collating legacy soil and agronomic data, the implementation of a careful standardization and harmonization mission for

legacy data is indispensable for national synthesis. It is advisable to follow global and national soil data standardization and harmonization guidelines such as the World Soil Information Service (WoSIS)- Towards the standardization and harmonization of world soil data [2].

Various institutions have made efforts since 1963 to generate soil information for Ethiopia for assessing the agricultural development potential of each soil. These studies varied widely in scope, scale, and approach as well as in the quality of outputs [3]. The first attempt to map the soils of Ethiopia was made by Schantz and Marbut in 1923 as part of the mission of mapping the soils of Africa at a scale of 1:25 million. Among early efforts was the soil fertility survey conducted by who also studied the general fertility status of soils in Ethiopia by collecting some 2,600 samples along the main roads across the country [4].

Proficiency testing (PT) is a significant component in the laboratories competency process as it allows laboratories to monitor the quality of their analytical results as stipulated in ISO/IEC 17025. There are a number of benefits to participating in PT, including improving quality of analytical results measurements, demonstrating analytical competence, developing and training analysts, and the validation of methods and instruments. In this regard, Holeta Agricultural Research Center Soil laboratory takes an initiative to coordinate soil PT provision for interested soil laboratories (Fifteen soil laboratories of EIAR and regional centers) of Ethiopia.

The general objective of this PT evaluation is to monitor the quality of their analytical results, demonstrating analytical com-

petence, developing and training analysts, and the validation of methods and instruments as stipulated in ISO/IEC 17025 in Ethiopia. Among few accredited soil laboratories, Holeta Agricultural Research Center (HARC) soil laboratory has been accredited since 2014.

Methodology

Sample Collection and Preparation

Soil Samples were collected from agricultural fields representing a homogeneous soil type. Sampling depth most plants (Crops) root depth of 0-20cm. Care was taken during sampling to avoid any heterogeneous material other than the soil was mixed. Then, the sampled soil was air dried in soil preparation room, ground manually in a porcelain mortar and pestle and then sieved by 0.5mm mesh size.

Homogeneity and Stability Studies

Soil particles were difficult to mix and need repeated subsampling to make homogeneous. Therefore, after grinding dried sample and sieved by 0.5mm sieve size, the bulk sample was divided in to sub samples by using rotary sample divider. Each sample was subjected to homogeneity and stability test before dispatched to each participating laboratory.

All fifteen soil laboratories of EIAR & regional centers participated in the PT organized for 2022. About 10 kg of a soil sample was sampled from Wemera District located in West Shewa Zone of Oromia. It was prepared following the standard procedure. Samples dispatched to each participating laboratory were homogenized using rotary sample divider equipment. Then, homogeneity test performed before dispatched to each participating laboratory to ensure every laboratory receive the same item.

Data Analysis

Participant's performance was evaluated by calculating Zscores: $z_i = (x_i - \bar{x}) / \sigma_{pt}$. The following criteria were used for the performance assessment. $Iz - score \leq 2.0$: Satisfactory Performance, $2.0 < Iz - score < 3.0$: Questionable Performance, $Iz - score \geq 3.0$: Unsatisfactory Performance

Result and Discussion

All laboratories submitted the analysis result based on the instruction though some laboratories lately submitted the results. Most of the laboratories tested and submitted results for about six parameters as indicated in the Table 1.

Table 1: Soil Pt Report for Some Parameters by Most of Soil Laboratories

No.	Centers	PH (1:2.5)	% OC	% TN	Avail. P ppm bray II
1	1	4.85	3.33	0.30	19.23
2	2	4.82	3.48	0.35	-
3	3	4.62	3.26	0.29	-
4	4	4.65	2.96	0.29	5.22
5	5	4.68	2.79	0.27	5.38
6	6	4.79	3.20	-	18.50
7	7	4.60	3.86	0.23	2.92
8	8	4.62	3.71	0.21	2.98
9	9	4.58	3.39	0.33	-
10	10	4.53	2.98	0.274	-
11	11	4.50	3.46	0.24	-
12	12	4.7	4.10	0.35	-
13	13	4.81	3.25	0.296	14.22
14	14	4.47	3.27	0.31	3.35
15	15	4.60	3.62	0.31	7.02

Evaluation of Soil PT Participating Laboratories (Z-scores)

The Z score analysis was performed only for four parameters (pH-H₂O, TN, Avail. P and OC) using the software as they fulfill the minimum number of participants for analysis i.e. fifteen. The evaluation result (Z score and assessment) is indicated in each of the following Table. Soil pH was measured using digital pH meter in 1:2.5 soil to solution ratio with H₂O, the organic carbon was determined following wet digestion methods as described by and whereas the Kjeldahl procedure was used for the determination of total N as described by [5-8]. The available P was determined by Bray II method [9].

Soil pH-H₂O

From fifteen participants, soil lab 01, 02, 04, 05, 06 11 and 12 scored satisfactory result for pH-water analysis. While soil lab 03, 07, 08, 09 and 15 scored questionable result that can be improved with taking a corrective action (for example: calibrating the pH meter with carefully prepared pH buffer solutions). But the soil lab 10, 11 and 14 scored unsatisfactory result that questioned the reliability of the labs reporting soil pH for customers. So, the labs should take serious measures (analysing the root cause and takes corrective action) to improve the analytical performance for testing a soil pH.

No.	Laboratory	PH (1:2.5)	Z-score	Assessment
1	1	4.85	0.2	S
2	2	4.82	-0.1	S
3	3	4.62	-2.2	Q
4	4	4.65	-1.9	S
5	5	4.68	-1.6	S
6	6	4.79	-0.4	S
7	7	4.60	-2.4	Q
8	8	4.62	-2.2	Q
9	9	4.58	-2.6	Q
10	10	4.53	-3.1	N
11	11	4.50	-3.4	N
12	12	4.7	-1.3	S
13	13	4.81	-0.2	S
14	14	4.47	-3.7	N
15	15	4.60	-2.4	Q

S = Satisfactory [z-score] \leq 2.0; n = Not Satisfactory [z-score] \geq 3.0; q = Questionable 2.0 < [z-score] < 3.

Soil Organic Carbon

From fifteen participants, soil lab 1,2,3, 6,9, 11, 13,14, and 15 scored satisfactory result for OC analysis. Soil lab 4, 7, 8 and 10 scored questionable result and the lab can improve with taking slight corrective action. However, the soil lab 02, 03, 05 and 08

scored unsatisfactory result that questioned the reliability of the labs reporting soil OC for customers. Soil lab.5 and 12 score not satisfactory and rejectable. So, the labs should take serious measures (analysing the root cause, implement and document appropriate corrective action) to improve the OC testing result.

No.	Laboratory	% OC	Z-score	Assessment
1	1	3.33	-0.4	s
2	2	3.48	0.4	s
3	3	3.26	-0.9	s
4	4	2.96	-2.6	q
5	5	2.79	-3.6	n
6	6	3.20	-1.2	s
7	7	3.86	2.7	q
8	8	3.71	1.8	s
9	9	3.39	-0.1	s
10	10	2.98	-2.5	q
11	11	3.46	0.3	s
12	12	4.10	4.1	n
13	13	3.25	-0.9	s
14	14	3.27	-0.8	s
15	15	3.62	1.3	s

S = Satisfactory [z-score] \leq 2.0; n = Not Satisfactory [z-score] \geq 3.0; q = Questionable 2.0 < [z-score] < 3.

Soil Total Nitrogen

From fourteen participants, soil lab 1,2,3, 4, 9, 12, 13 and 15 scored satisfactory result for TN analysis. Soil lab 5, 10, 8 and 14 scored questionable result can improve with taking slight cor-

rective action and the soil lab. 7, 8 and 11 scored not satisfactory and rejectable. So, the labs should take serious measures (analysing the root cause, implement and document appropriate corrective action) to improve the TN testing result.

No.	Centers	% TN	Z-score	Assessment
1	1	0.30	-1.3	S
2	2	0.35	1.3	S
3	3	0.29	-1.8	S
4	4	0.29	-1.8	S
5	5	0.27	-2.8	Q
6	6	ND	ND	ND
7	7	0.23	-4.9	N
8	8	0.21	-5.9	N
9	9	0.33	0.3	S
10	10	0.274	-2.6	Q
11	11	0.24	-4.4	N
12	12	0.35	1.3	s
13	13	0.296	-1.5	s
14	14	0.31	-0.8	s
15	15	0.31	-0.8	s

S = Satisfactory [z-score] ≤ 2.0; n = Not Satisfactory [z-score] ≥ 3.0; q = Questionable 2.0 < [z-score] < 3.

Soil Available Phosphorus

From nine participants, soil lab 1, and 6 scored satisfactory result for TN analysis. Soil lab 4, 5, 7, 8, 13, 14 and 15 scored

not satisfactory and rejectable. So, the labs should take serious measures (analysing the root cause, implement and document appropriate corrective action) to improve the TN testing result.

No.	Centers	Avail.P ppm bray II	Z-score	Assessment
1	1	19.23	0.0	S
2	2	ND	-	
3	3	ND	-	
4	4	5.22	-9.1	N
5	5	5.38	-9.0	N
6	6	18.50	-0.5	S
7	7	2.92	-10.6	N
8	8	2.98	-10.6	N
9	9	ND	-	
10	10	ND	-	
11	11	ND	-	
12	12	ND	-	
13	13	14.22	-3.3	n
14	14	3.35	-10.3	n
15	15	7.02	-7.9	n

S = Satisfactory [z-score] ≤ 2.0; n = Not Satisfactory [z-score] ≥ 3.0; q = Questionable 2.0 < [z-score] < 3.

Conclusions

From the above result the laboratories should take serious measures (analyzing the root cause, implement and document appropriate corrective action) to improve the OC, TN and Available P testing result. However, the data generated from the Ethiopian soil laboratories are not reliable enough and need to improve their analytical services quality. Reliable and acceptable data was generated when laboratories fulfill ISO/ IES 17025 standard, gets an accreditation certificate and participate in Proficiencies tests.

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