Food and Agriculture Organization of the United Nations

Proficiency Tests and Interlaboratory Comparisons

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2nd meeting of the International Network on Fertilizer Analysis (INFA)
Virtual meeting | 29-30 June 2021 - 02:00 PM CEST

GLOBAL SOIL PARTNERSHIP

Rationale

- The world's population increasing
- Increased agricultural production will be required to support the growth of the population, but .. reality it is decreasing due to soils degradation, miss management etc.
- Fertilizers are regarded as responsible for the pollution of water supplies, harming the soil structure, leading to intensive agriculture which disfigure the countryside
- to ensure future food supplies by promoting their correct use is the must consideration at this stage
- The consequences of injudicious fertilizer use are significant for the

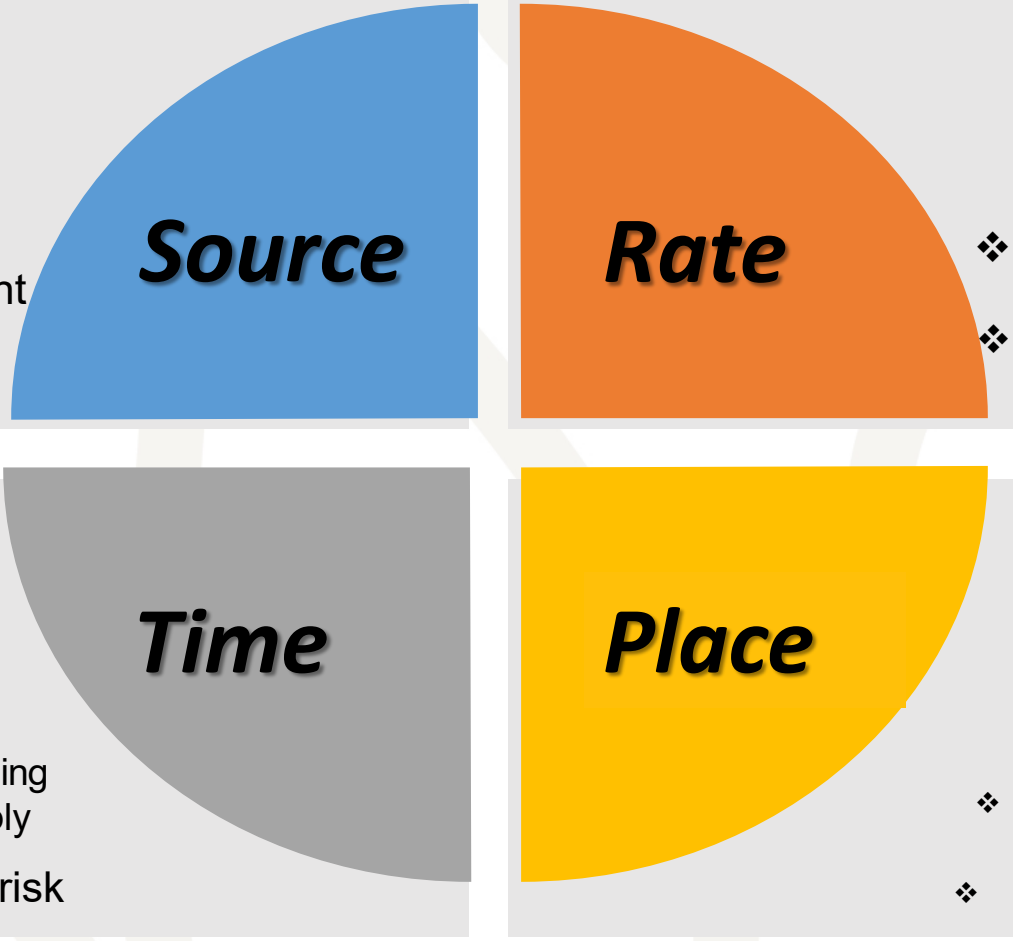
environment and have resulted in several jurisdictions of legislative tools to manage grower practice.

4 R Nutrient management

reducing negative environmental impacts due to improper fertilizer use?

SOURCE

- Suitable to soils
- Suitable to crop
- Apply nutrients in plant available form



RATE

- Assess all reserves nutrients
- Assess plant demand
- Ensure balance supply

TIME

- Assesses dynamics and timing of crop uptake and soil supply
- Determine time of loss risk

PLACE

- Recognize Crop Rooting Patterns
- Manage Spatial Variability

TO BE ABLE TO :

Facilitate exchange of scientific data, methodologies and research applications among various stakeholders to support national/country-level research

YOU NEED LABORATORY:

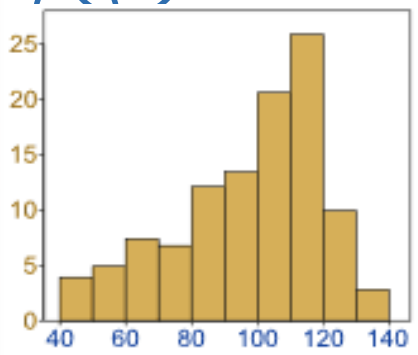
To provide comparable and reliable fertilizer testing results

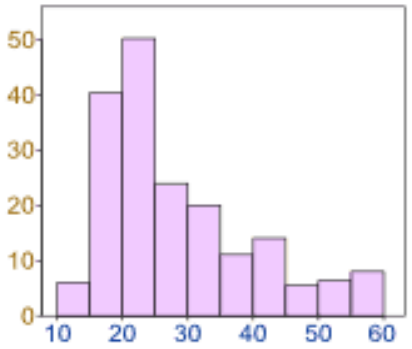
When sending a same fertilizer sample to any fertilizer testing laboratory…

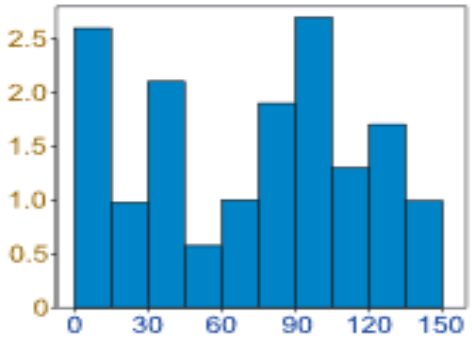
When sending a same fertilizer sample to any fertilizer testing laboratory…

your expectation is…

…**to get the same results!** (+/- uncertainty)

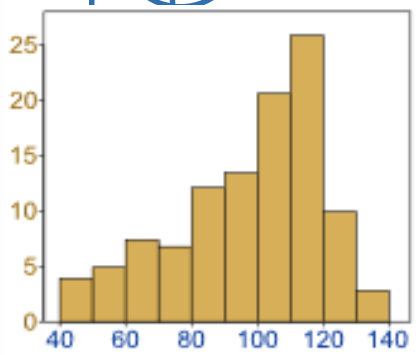


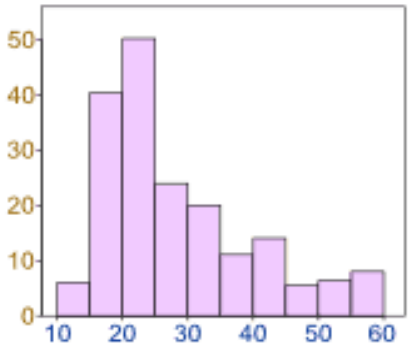


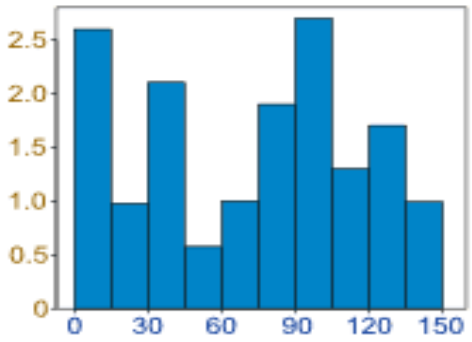


When sending a same fertilizer sample to any fertilizer testing laboratory…

…and thus…
to obtain the **same** or provide **similar** **fertilizer quality and recommendations**, etc.







Laboratory with consistancy comparable and reliable data

- Testing method : harmonized and validate
- Laboratory staffs : well trained and knowledgeable
- Quality control : internal and external quality control implemented
  - IQC : use RM/QC samples/quality control chart
  - EQC : Interlaboratory Comparison(ILC)
    Proficiency test (PT)

- **Interlaboratory Comparison (ILC)**

  looks at measurement results by two or more laboratories on the same or similar items

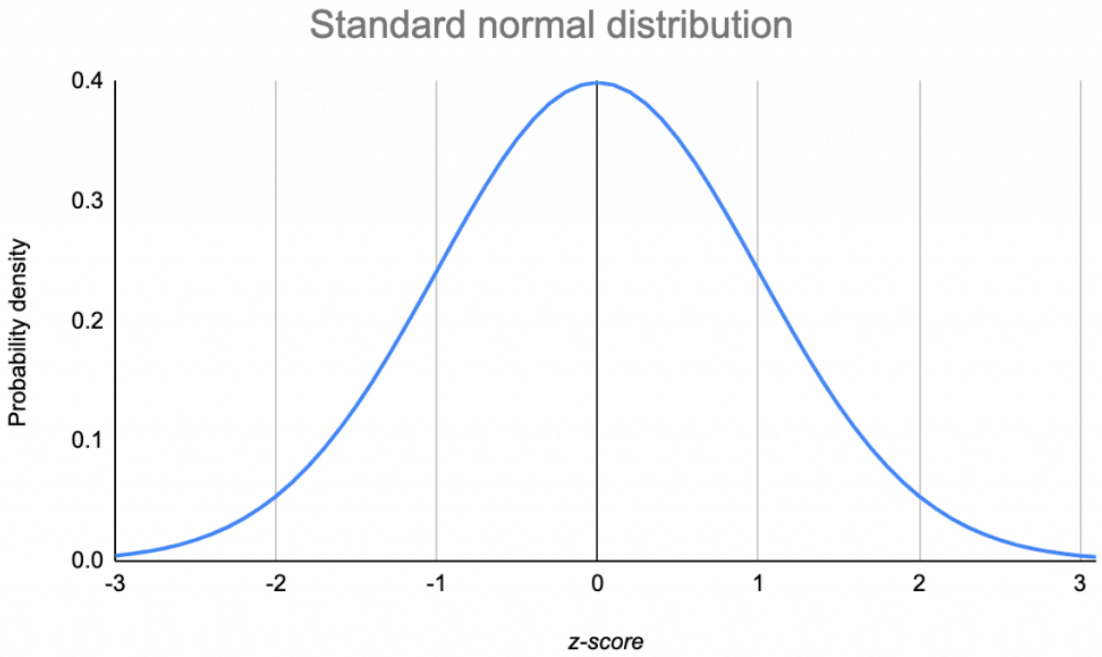
- **A proficiency test (PT)**

  determination of laboratory testing performance by means of interlaboratory comparison (ILC)

  PT having a coordinating body and a formal report which clearly outlines the Z score

What is Proficiency Testing

- Evaluating the laboratory performance by inter laboratory comparison using the consensus value calculate from
- PT is the external quality control activity, it shall perform to evidence on laboratory performance and is one of the
- A program designed as a statistical quality control tool enabling participating laboratories to assess their performance



Benefit of Laboratory joining Proficiency Testing

01 Support the technical validity of laboratory results

02 Protect your interest in trade transactions

03 Establishment of comparability of test or measurement methods

04 Identification of problems in laboratories and initiation of actions for improvement

05 Verify analyst proficiency and Use as laboratory quality control materials

PT and Accreditation

- To achieve initial accreditation a laboratory must be able to demonstrate successful participation in at least one PT event.
- - Corrective action must be taken for any outlying results.
- Unacceptable PT results may result in an adverse accreditation action such as suspension of that test from the scope until the lab can demonstrate acceptable performance

Limitation of Proficiency Testing

01

It has to be carried out within the context of a complete system in each laboratory

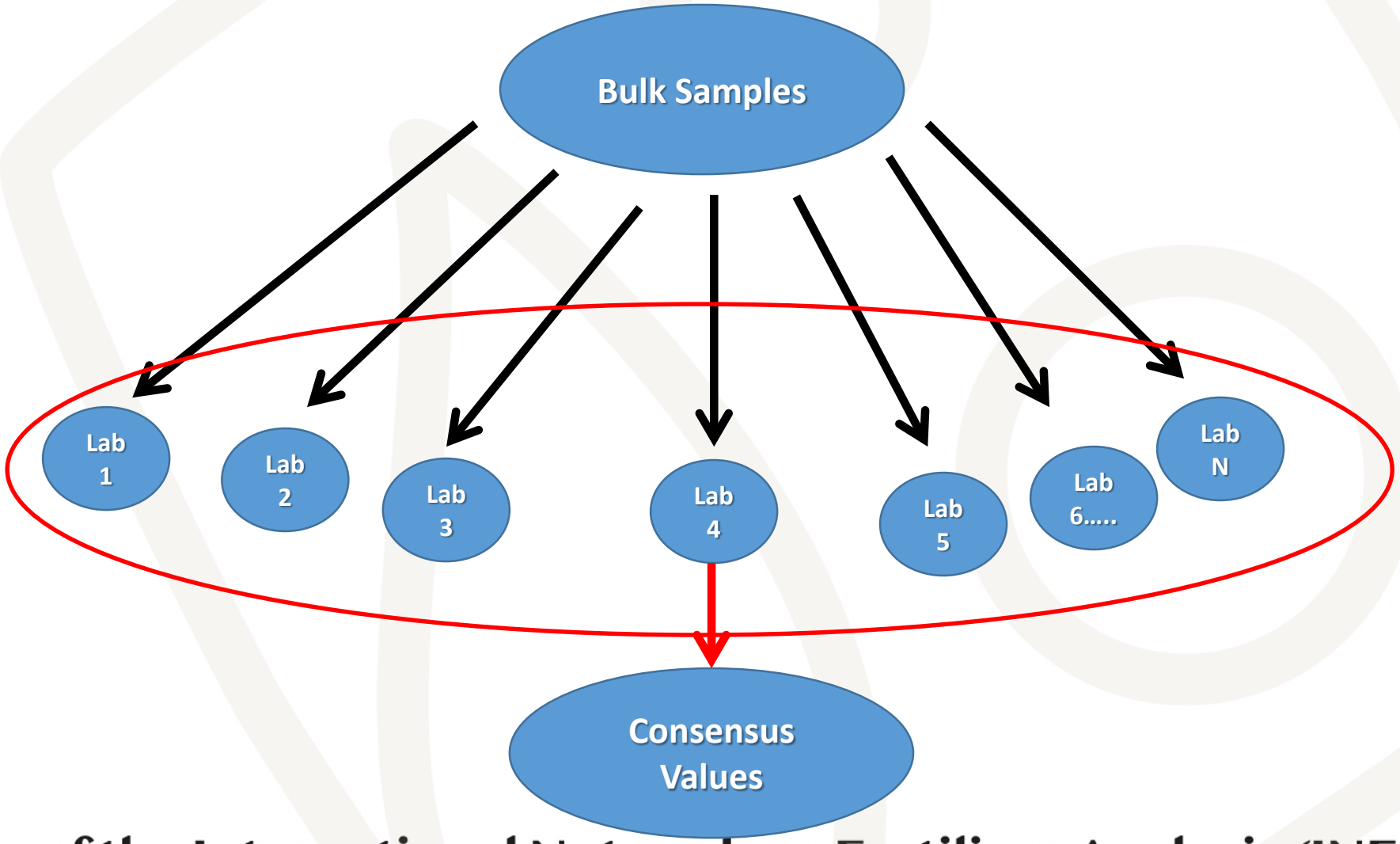
It provides a participating laboratory only with an indication of problems if they are present. But it does

02

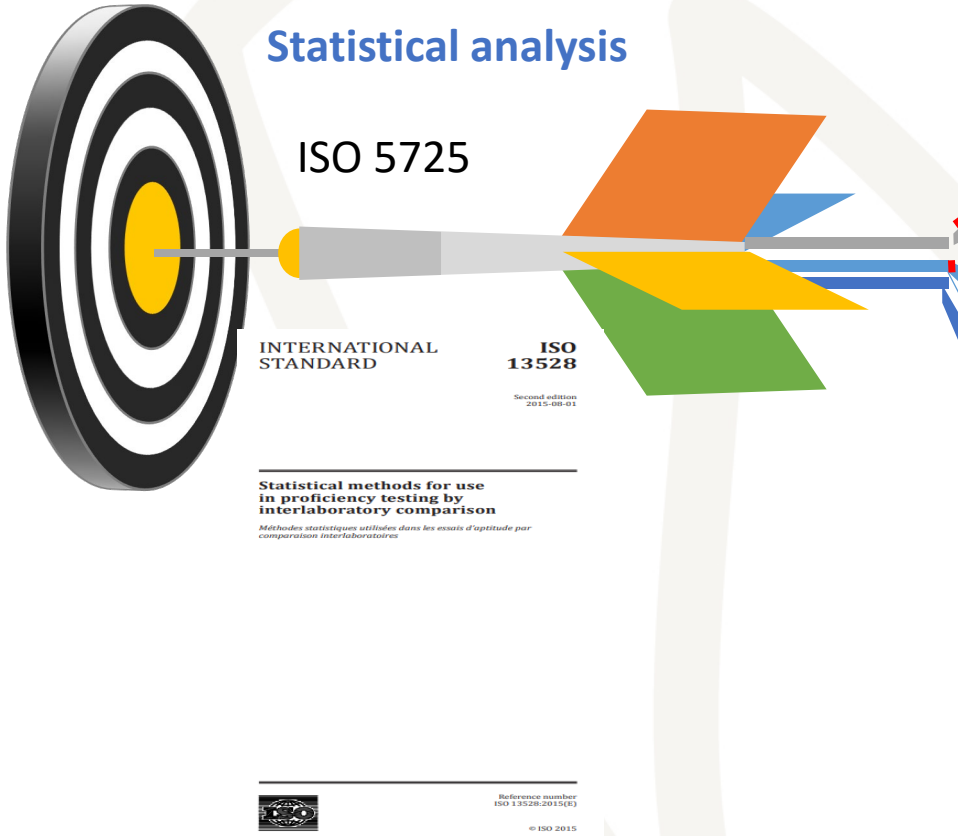
03

Success in a PT for one analyze does not mean that a laboratory is equally competent in other

Typical Proficiency Test



☑ Important steps for the



01 **Sample preparation**

02 **Sample homogeniety test**

03 **Sample stability test**

04 **Sample distribution**

05 **Analysis by participating laboratories**

06 **Statistical assessment of the participants performance**

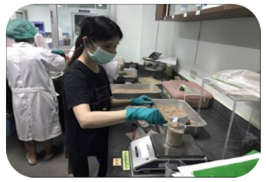
Sample Preparation

Dry soil sample

Grind the soil sample

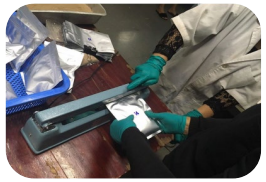
Sieve through 2 mm and then through 0.5 mm

Soil mixing



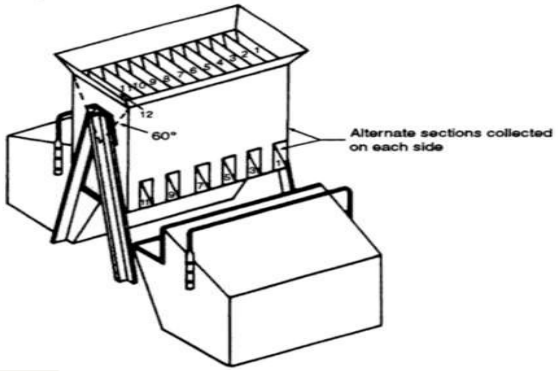
Weighting

Packing



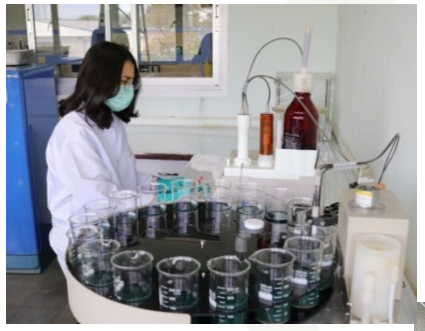
Sealing

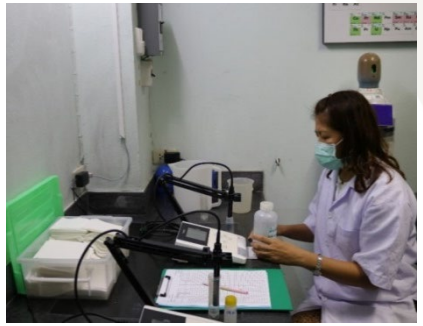
Label



- Riffle box

Homogeneity and stability test





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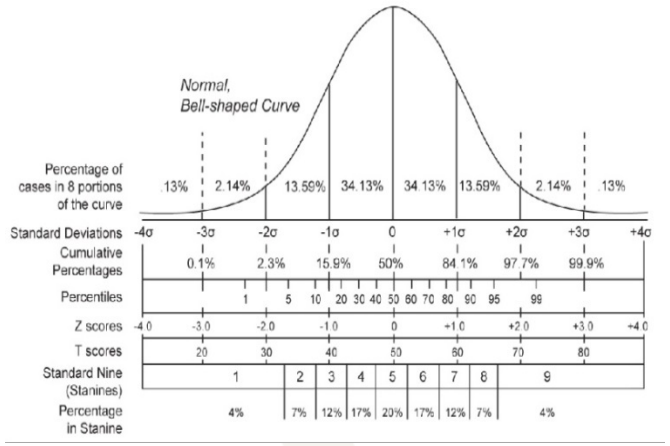
GLOBAL SOIL PARTNERSHIP

☑ Statistical design and the evaluation of the



Homogeneity test 01

Stability test 02

- Assigned value; X_{pt}
- Standard uncertainty of the assigned value u_x

03

Standard deviation for proficiency assessment; $\hat{\sigma}/\sigma_{pt}$ 04

Calculate Z-Score 05

Homogeneity Test

random 10%

Duplicate analysis

Statistical analysis

Homogeneity test within sample variation

Duplicate analysis:

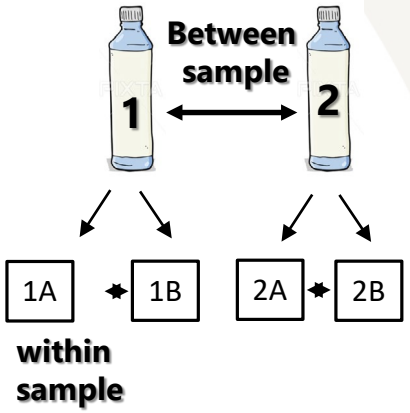
Cochran's maximum range test

Calculate the ratio: $\frac{D_{max}^2}{\sum D_i^2}$

where

D_{max} = the maximum difference of the duplicates

D_i = difference of each pair of duplicates

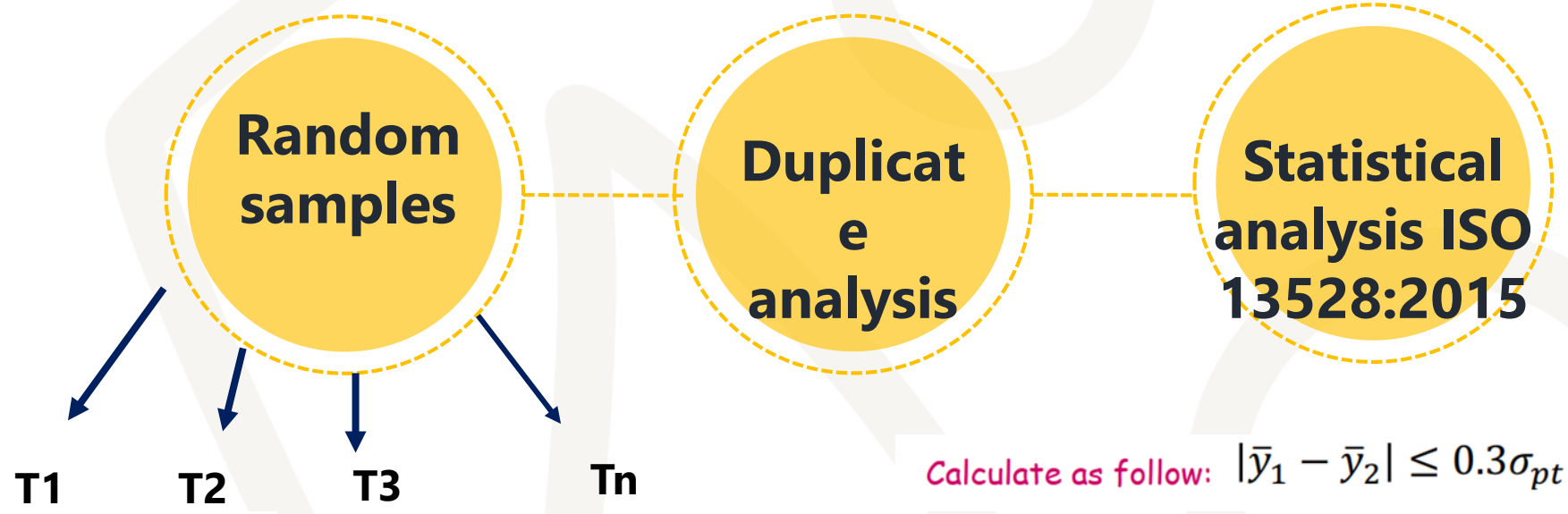


Homogeneity test Between Sample Variations

- One way ANOVA
- ISO 13528:2015

$$s_s \leq 0.3\,\sigma_{(pt)}$$

Stability Test



If not adequately stable : use expand criteria

$$\left|\bar{y}_1 - \bar{y}_2\right| \leq 0{,}3\sigma_{pt} + 2\sqrt{u^2(\bar{y}_1) + u^2(\bar{y}_2)}$$

Calculate as follow: $|\bar{y}_1 - \bar{y}_2| \leq 0.3\sigma_{pt}$

$\bar{y}_1$ = Mean value from homogeneity of test material

$\bar{y}_2$ = Mean value from stability each storage time

σ_{pt} Robust Standard Deviation for Assessment

Evaluating the performance of laboratory and statistical treatment of data

- The **assigned value** to each measurement is represented by the **consensus mean** calculated either according to algorithm "A" ISO 13528:2015 or other statistical tools that fit to the data (arithmetic mean etc)
- The uncertainty measurement of the assigned value is calculated based on standard deviation by the formula:

$$u_x = 1.25 \times \frac{s^*}{\sqrt{p}}$$

Reference: ISO 13528:2015

u_x = Uncertainty of assign value

s^* = Robust standard deviation

p = number of results

Determination of Assigned value; X_{pt}

Assigned value, is a mean or median value that serves as an agreed-upon reference for comparison; normally derived from or based upo

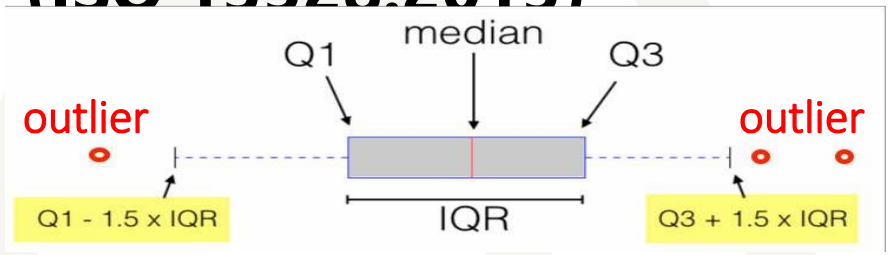
- ❖ the CRM reference value
- ❖ a single laboratory using a ref method on PT item and CRM, RM
- ❖ expert laboratories
- ❖ **participant results**

exclude outliers using algorithm A

calculate consensus mean from Robust mean (x^*) according to Algorithm A (ISO 13528:2015)

exclude outliers using IOR or others to identify statistical

etc)



if the data is normal distribution ==> the mean can be used !

no need of 'robust' (= using median) statistics

Determination of Z-Score or Z' Score

- calculated Z-Score when the measurement uncertainty is negligible or $u_{x(pt)} \leq 0.3\sigma_{pt}$
- calculated Z'-Score when the measurement uncertainty is not negligible or $u_{x(pt)} > 0.3\sigma_{pt}$

$$Z - Score = \frac{x_i - x_{pt}}{\sigma_{pt}}$$

$$Z' = \frac{(x_i - x_{pt})}{\sqrt{\sigma_{pt}^2 + u^2(x_{pt})}}$$

x_i = Participant report's result

$x_{(pt)}$ = Robust mean

$\sigma_{(pt)}$ = Robust Standard Deviation

$u_{x(pt)} = uncertainty\ of\ measurement$

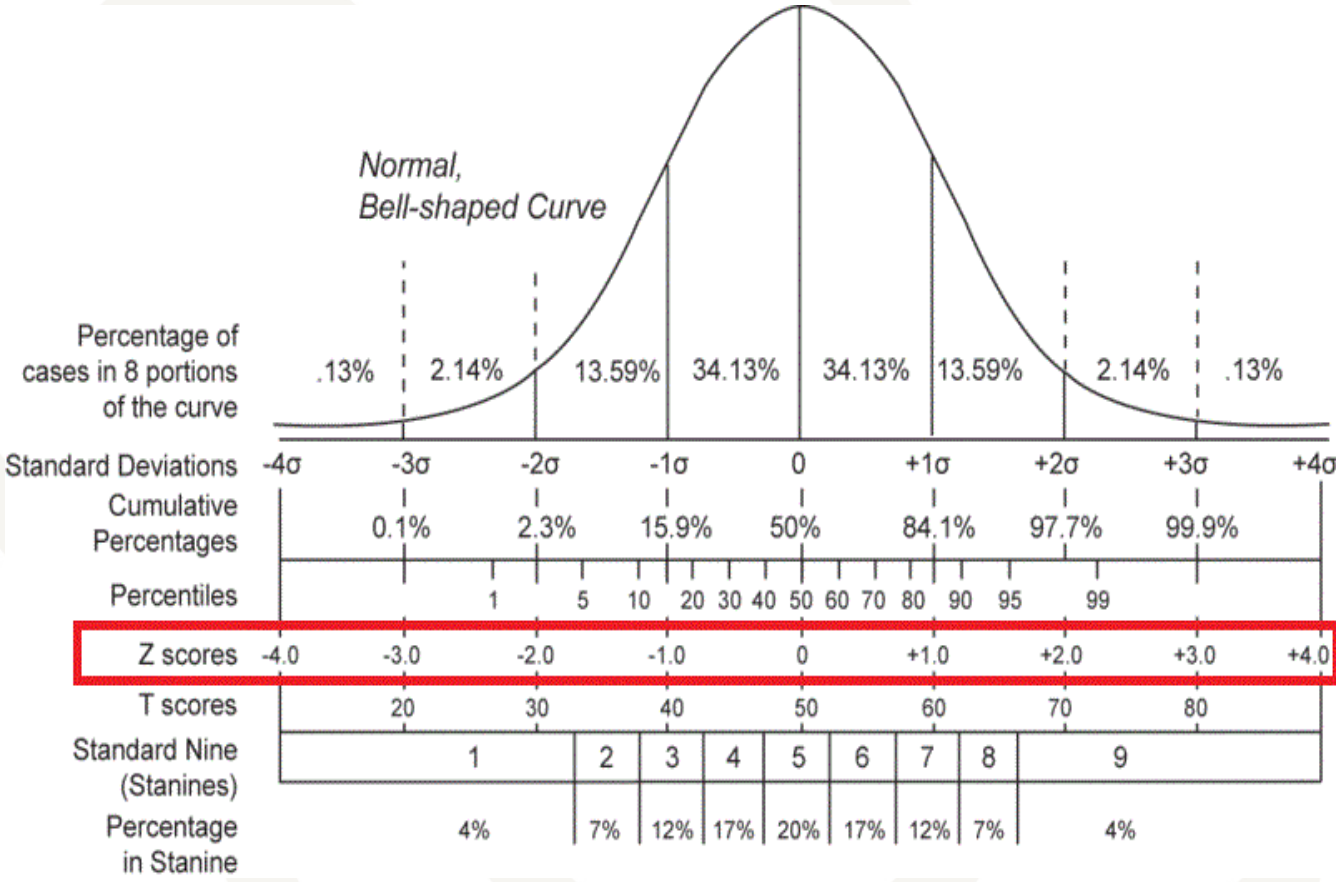
Z-Score interpretation

|z| score ≤ 2 is satisfactory

2 < |z| score < 3 is questionable

z score ≥ 3 is unsatisfactory

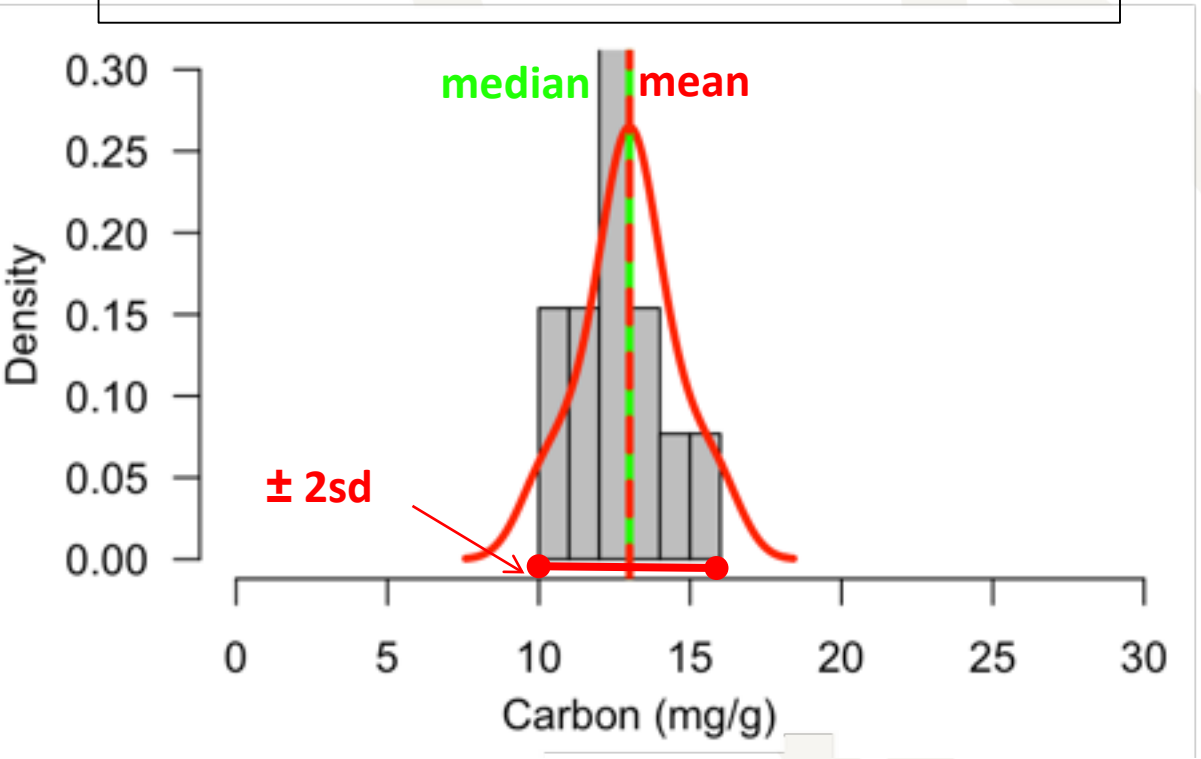
(*ref ISO/IEC 17043:2010, B.4.1.1, ISO 13528:2015):*



Z-score of -1 is that about 34.13% of the laboratory got result **below** the consensus mean.
Similarly, the Z-score of +2 implies that 47.42% of the laboratory got result **above** the consensus mean.

Determination of the Assigned value: mean vs median

For normal distribution:
mean = median



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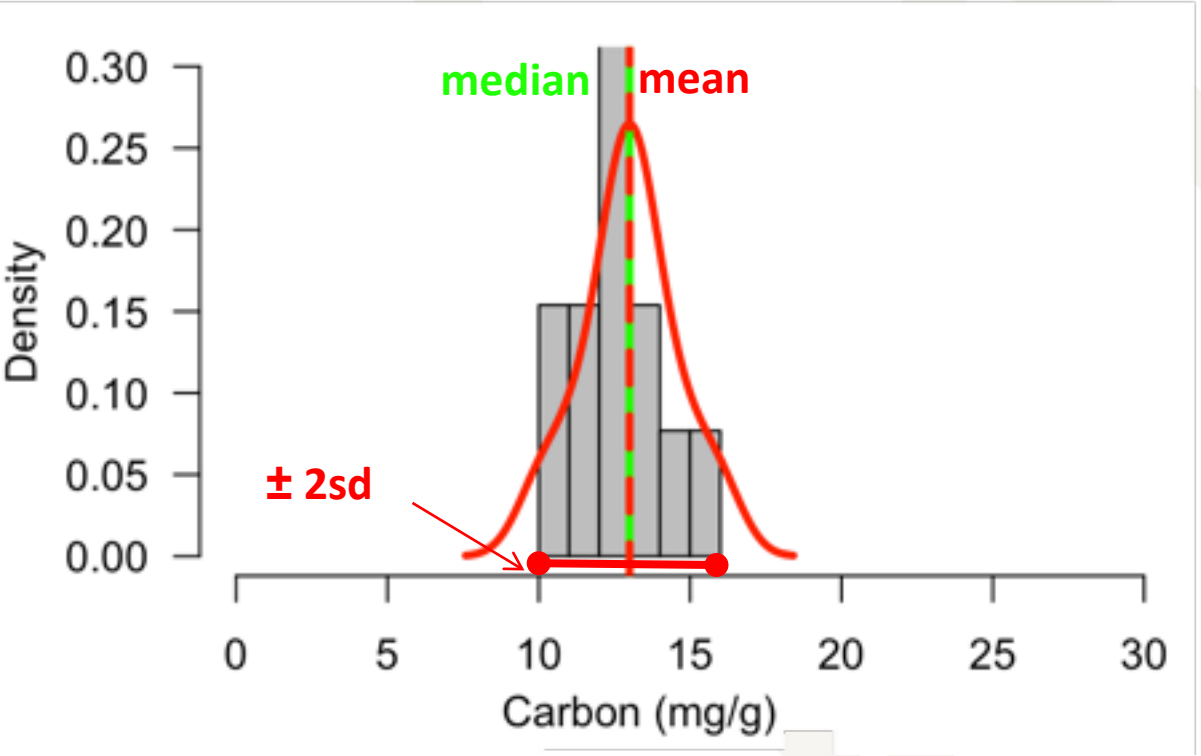
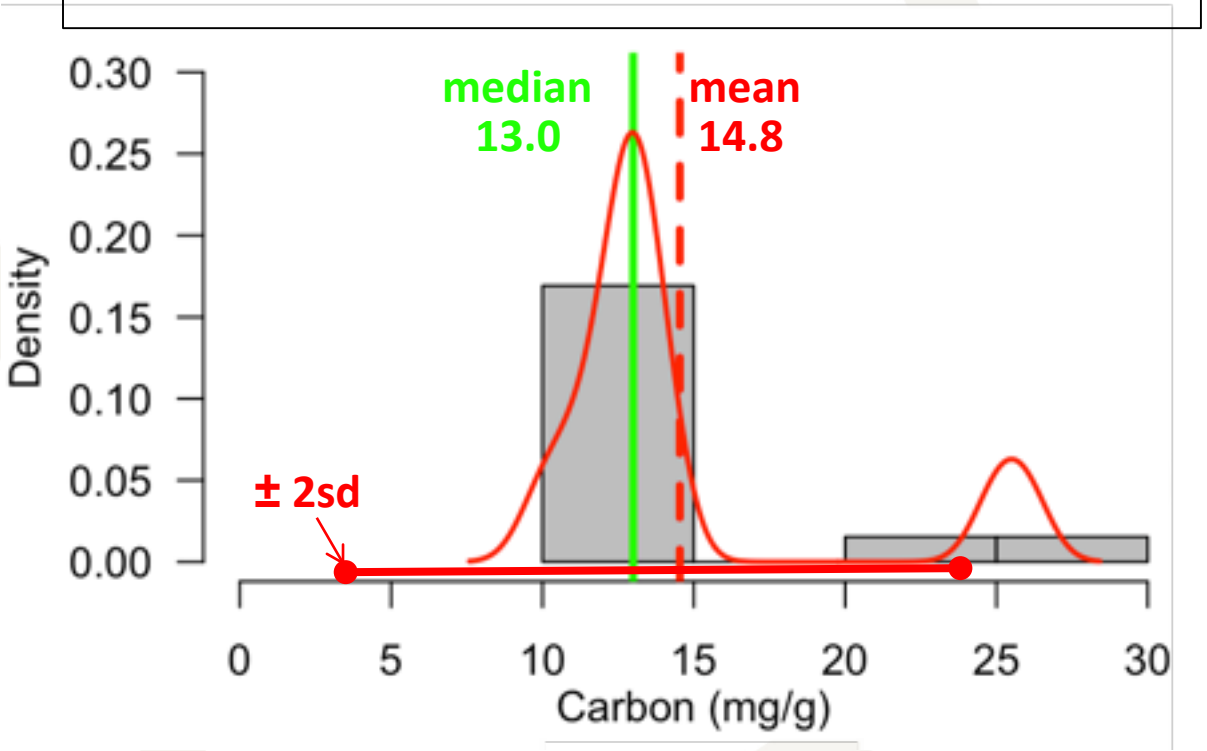
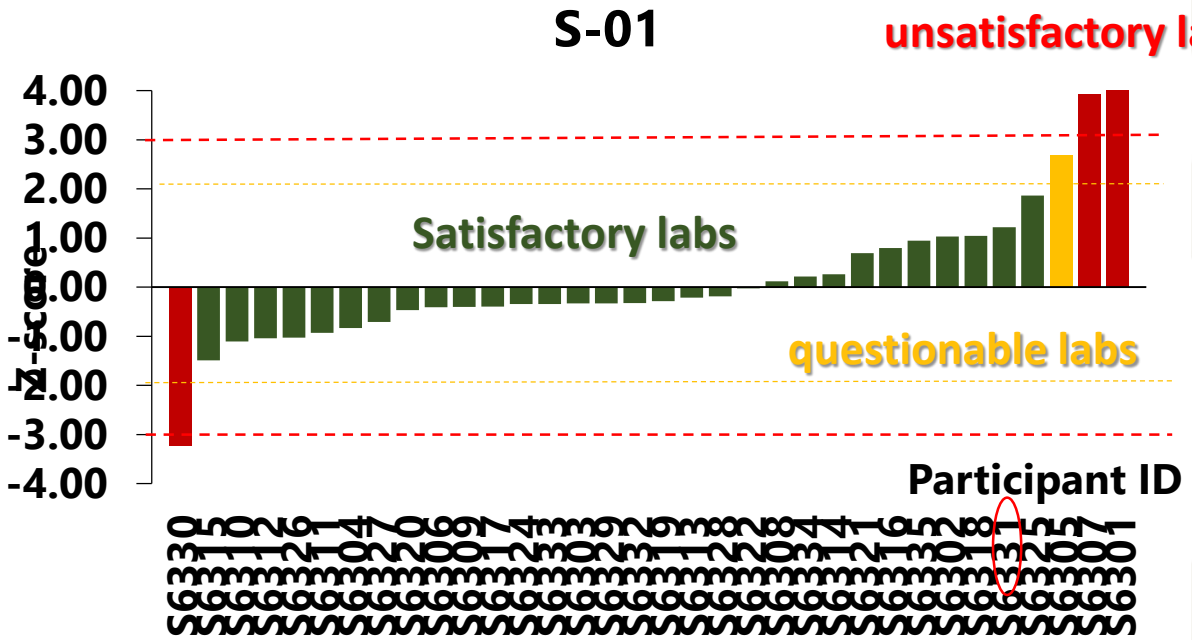
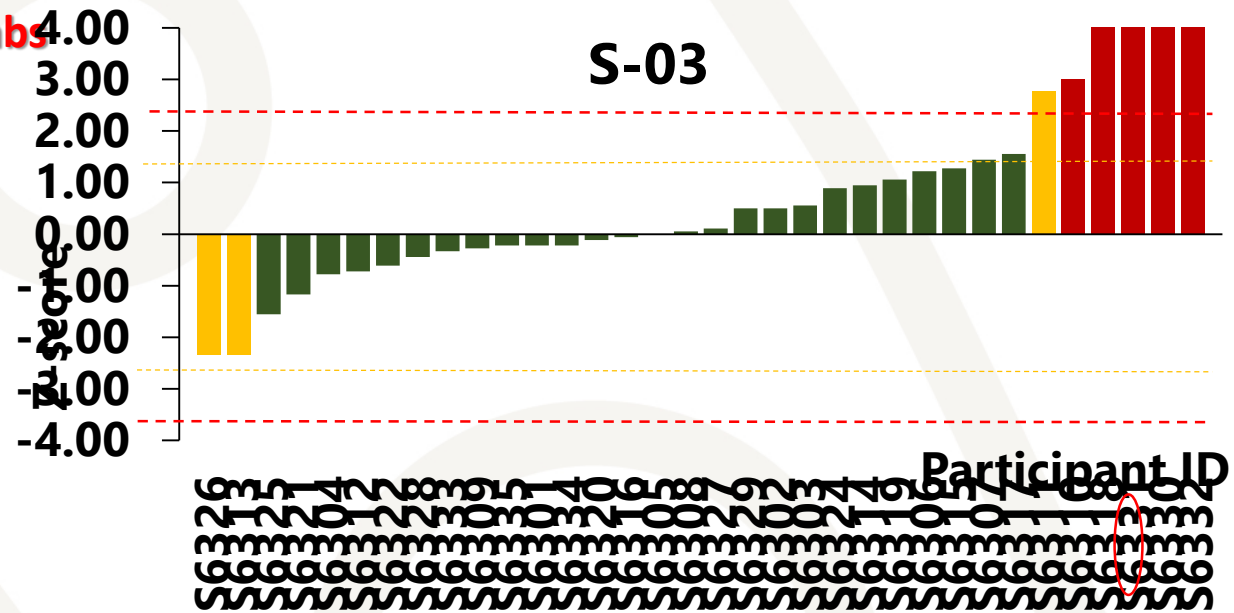


For NOT normal distribution:
mean ≠ median

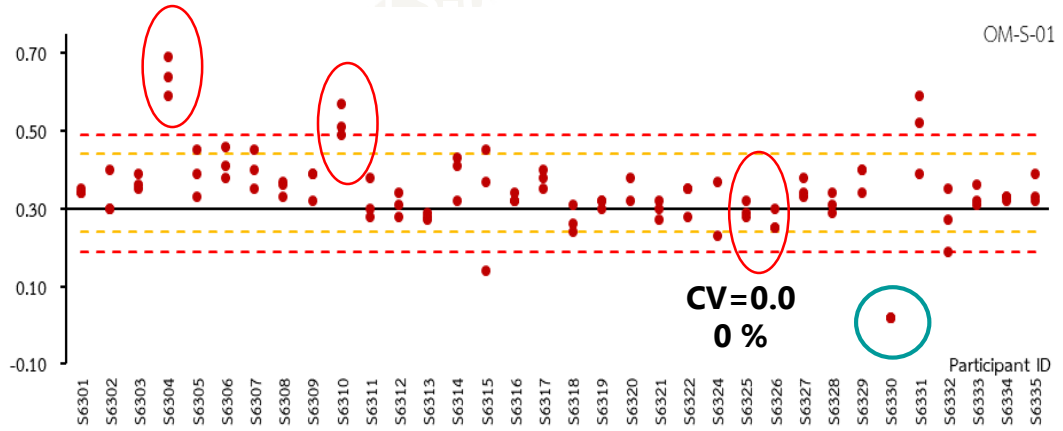


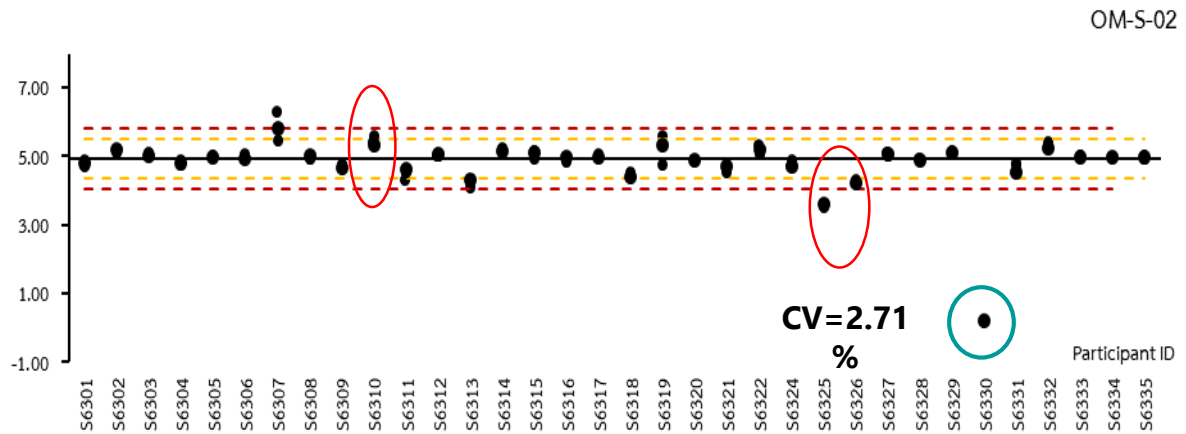


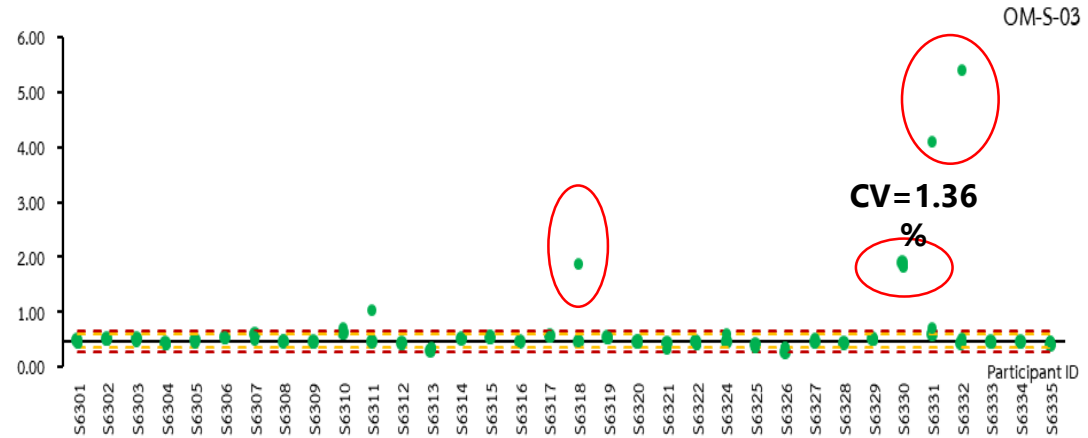


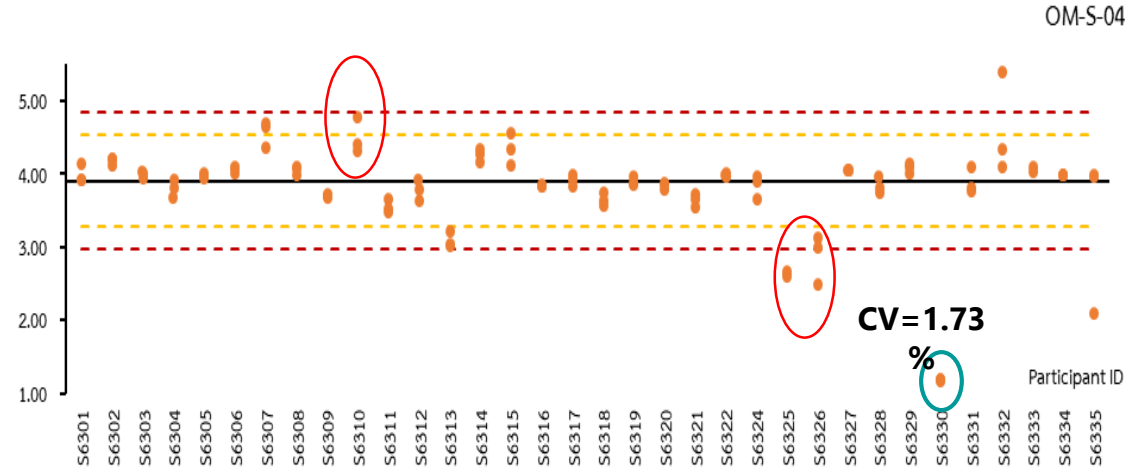
wrong data,
wrong conclusion,
wrong decision making in field and in political decision

Precision









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Conclusion

- A mandatory external quality control as interlaboratory comparison (ILC) or proficiency test (PT) is important for all laboratories in order to ensure for their comparable and reliable data
- With a participating to the ILC or PT programme, the quality of the laboratory and comparability of lab data will be test continuously
- ILC or PT consolidates or provides guidance for strengthening the approach to quality control of the laboratory.
- The results from the performance assessment of laboratory can be used for laboratory quality improvement


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