# ICAR AQA strategy – International anchorage and harmonisation

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## Summary

A reference system for milk recording analysis based on national and international laboratory networks has been developed to respond to the need of analytical harmonisation between countries. Proficiency testing schemes implemented nationally by countries and at the international level in a reference laboratory network by ICAR can be used for the benefit of laboratory quality assurance, through providing international reference anchorage and traceability. An international reference laboratory network like ICAR 's one can be used to certify reference materials that can further benefit to the harmonisation and improvement of analytical performances. High performance with methods is required from reference laboratories involved and proficiency studies can be used to select or qualify suitable candidate laboratories.

***Key words**: Milk recording, laboratories, Harmonisation, Quality assurance, Reference, Anchorage, Network.*

## Introduction

The policy for analytical quality assurance (AQA) implemented from 1994 has been based on the harmonisation of laboratory practices and analytical performance laboratories in ICAR member countries thanks to missions devoted to expert laboratories, so-called reference laboratories as justified by strong technical competence. Those missions refer to lab monitoring, expertise and service supply for quality assurance (QA) and quality control (QC). ICAR countries have been invited to nominate or create minimum one such a laboratory for national milk recording so that the whole of reference laboratories can become members of an active international reference laboratory network.

The international reference laboratory network has become an essential piece of the AQA system aiming at analytical harmonisation as its members are entrusted to be intermediaries between national levels and the international level where optimum methods and practices are defined (IDF/ISO guides and standards, ICAR Guidelines) to transmit adequate information to milk testing laboratories.

## International anchorage

International anchorage is made:

- First, through same/similar practices in every ICAR countries which is achieved through using same international standards and guides.
- Second, establishing concrete technical links between the high level of expertise (international reference laboratories) and routine testing laboratories in every country.

A technical linkage is to be made between the unknown truth given by the consensus of international milk recording community – represented by average results produced by the international reference laboratory network – and the final results obtained by testing laboratories.

It can be achieved through two major tools that can be implemented in parallel at both national and international levels with proper connection, correspondence and relay.

- Interlaboratory proficiency schemes: measuring lab performances. Through adequate combination, it is possible to establish and measure the chaining of errors in analytical steps that contribute to the final result (with regard to the reference methods and routine methods).
- Interlaboratory certification schemes: determination of true (or reference) values for reference materials (RMs).

## Performance evaluation

A protocol was adopted by ICAR for regular ICAR proficiency studies – international level – and is to be proposed in guidelines to ICAR countries for national implementation. Trials use q=10 samples evenly distributed throughout the concentration range of usual milk analyser calibration and labs perform duplicate analyses (n=2).

Lab evaluation is made through the laboratory bias - average of differences $\overline{d}_{Lk}$ measured between lab results and the reference value $\overline{X}_S$ (grand mean of all the labs per sample) - and the standard deviation of differences as an indicator of consistence (outlier result).
Laboratory score $\overline{d}_L = \Sigma\ \overline{d}_{Lk} / q = \overline{x}_L - \overline{X}$ must lay within the limits associated to uncertainty of $\overline{d}_L$

$$U_{dL} = \pm 2.(U_{xL}^{\ 2} + U_{X}^{\ 2})^{1/2} \text{ or } U_{dL} = \pm 2.[(\sigma_R^2 - \sigma_r^2.(1-1/nq).(1+1/p)]^{1/2}$$

Beside punctual elements of within lab reproducibility can be estimated through

$$sR_L^2 = sr^2.(1-1/n) + \overline{d}_L^2 + sd^2$$

with estimate calculated by averaging precision elements of several successive trials. Within lab reproducibility standard deviation can then be used for determining uncertainty of test results.

## Result uncertainty

Precision and accuracy elements produced through PT results and analyser monitoring and calibration allow to calculate the overall accuracy and uncertainty of routine testing results in a laboratory. To realise adequate estimation elements used are to be obtained from sufficient numerous data.

For the reference methods (q samples and n replicates) it is calculated according to ISO 5725-6 as

$U_{ref} = \pm u_{0.975} .[sR_{L,ref}^2 - sr_{L,ref}^2.(1-1/nq)]^{1/2}$ and with high nq (calibration)
$U_{ref} \approx \pm u_{0.975} .(sR_{L,ref}^2 - sr_{L,ref}^2)^{1/2}$
For routine (alternative) methods, it is estimated according to ISO 8196 through
$U_{alt} \approx \pm u_{0.975} . (sR_{L,alt}^2 + s_{y,x}^2)^{1/2}$

Overall uncertainty of routine testing results U is obtained by combining both types of error as
$U \approx \pm u_{0.975} .(sR_{L,ref}^2 - sr_{L,ref}^2 + sR_{L,alt}^2 + s_{y,x}^2)^{1/2}$

## Traceability to an international reference

The reference laboratory of every national laboratory network participates in national and international proficiency studies in parallel. Special training and procedures to ensure trueness and performance stability what is checked through international PT results (re qualification of reference laboratories).

The bridge between national and international levels is calculated through the difference D between national and international references of parallel trials (Figure 2). The latter difference is calculated through the scores obtained by the reference laboratory M (master) in one and the other trials $\Delta = \overline{d}_{MN} - \overline{d}_{MI}$ provided laboratory bias is shown constant (established by several successive international PTs).

Since then any laboratory L can estimate a virtual equivalent international score from its national score by subtracting $\Delta$ : $\overline{d}_{LI} = \overline{d}_{LN} - \Delta$

Uncertainty of the estimate must take into account several steps involved in bridging so it is larger than a direct performance evaluation.

$U_{d\,LI} = \pm 2.[(\sigma_R^2 - \sigma_r^2.(1-1/nq).(3+1/p)]^{1/2}$

- with large nq and p (labs) values: $U_{dLI} \approx \pm 2.\sqrt{3}.(\sigma_R^2 - \sigma_r^2)^{½}$
- with highly qualified master laboratories ($\sigma_{RM} \approx \sigma_{rM}$ ) and large nq and p values: $U_{dLI} \approx \pm 2.(\sigma_R^2 - \sigma_r^2)^{½}$

## Comparison between laboratories

At a single level national or international it is easily realised through the difference

$\overline{d}_{1,2}$ of scores of respective laboratories L1 and L2 (Figure 1), since $\overline{d}_{1,2} = \overline{x}_{L1} - \overline{x}_{L2} = \overline{d}_{L1} - \overline{d}_{L2}$
It is expected to stay between
$\pm 2.\sqrt{2}\, U_{dL} = \pm 2.[(\sigma_R^2 - \sigma_r^2.(1-1/nq).(2+1/p_1+1/p_2)]^{1/2} \approx \pm 2.\sqrt{2}.(\sigma_R^2 - \sigma_r^2)^{1/2}$

Between different trials, a virtual equivalent international differences can be estimated provided reference laboratories can establish correspondence to the international level (Figure 3) where the virtual difference can be calculated by

$$\Delta = \overline{d}_{LI1} - \overline{d}_{LI2} = (\overline{d}_{LN1} - \overline{d}_{LN2}) - (\Delta_1 - \Delta_2)$$

With $\Delta_1 = \overline{d}_{MN1} - \overline{d}_{MI1}$ the bias of the reference of Trial 1 to that of the international trial

$\Delta_2 = \overline{d}_{MN2} - \overline{d}_{MI2}$ the bias of the reference of Trial 2 to that of the international trial

Uncertainty of the difference must take into account the several steps involved in bridging for two national networks and is calculated from uncertainty of the uncertainty of international correspondence formerly mentioned through

$\pm 2.\sqrt{2}.\ U_{d\ LI} = U_{dLI} \approx \pm 2.\sqrt{6}.(\sigma_R^2 - \sigma_r^2)^{½}$ and with highly qualified master laboratories ($\sigma_{RM} \approx \sigma_{rM}$) $U_{dLI} \approx \pm 2.\sqrt{2}.(\sigma_R^2 - \sigma_r^2)^{1/2}$

## Certification of reference materials

Same type of trials as PT studies can be used to determine true value for reference materials provided the experimental design permit so.

ICAR protocol fit for purpose since proficiency testing and possible reference material are made to assess reference method and/or calibrate routine methods. For that reason it is recommended the sample number must be the same as that used for calibration. The minimum stated in ISO 8196 is 9. Guidelines are to be develop with this respect in the future.

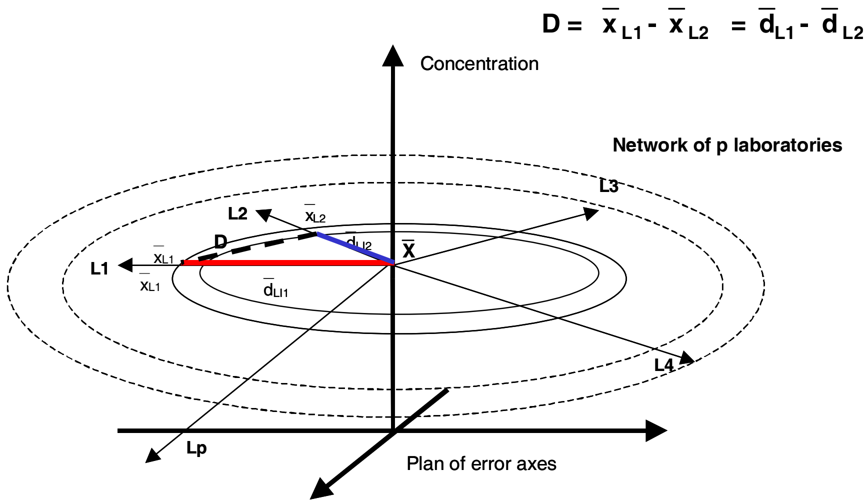


*Figure 1. Between laboratory comparison through an interlaboratory study.*

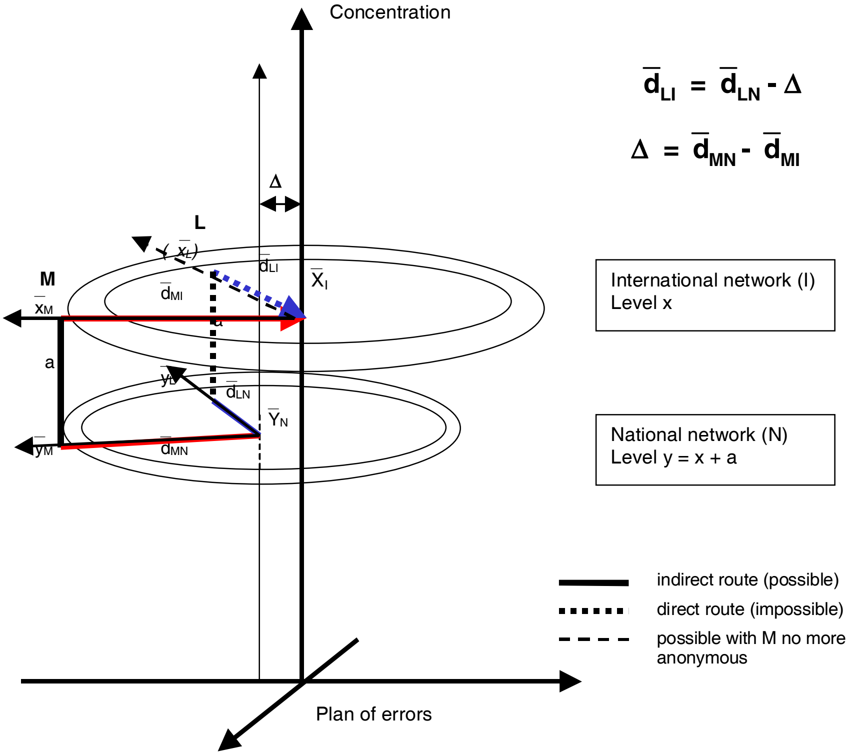


*Figure 2. Assessment of the absolute performance of a laboratory versus an international reference via a master laboratory.*

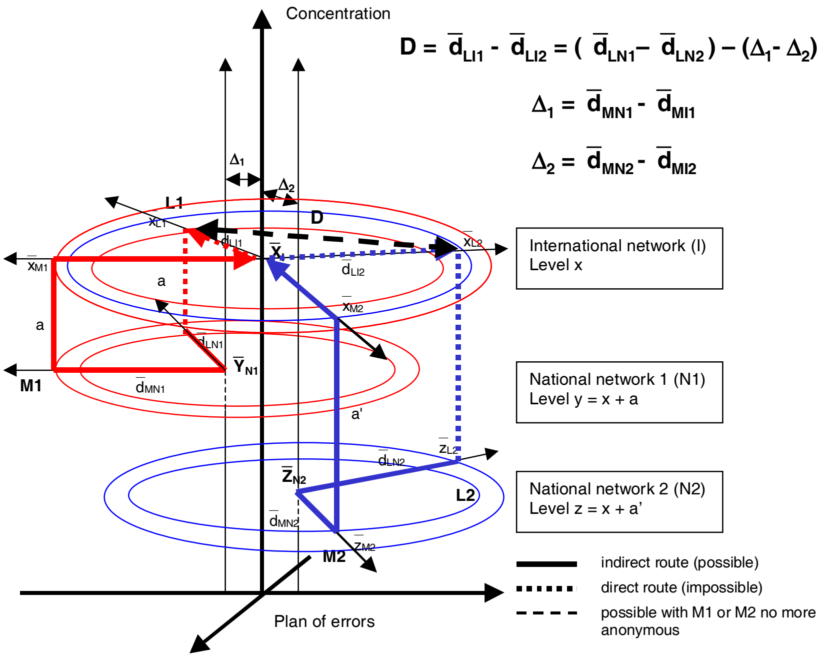


*Figure 3. Absolute assessment and between laboratory performance comparison via master laboratories.*

Thanks to performance evaluation through proficiency studies, it is possible to select best performing laboratories to establish true (reference) values for RMs. Otherwise the whole of participants can be used provided proper discarding of outlier results and laboratories.

ISO 5725 provides adequate recommendation for calculation of true values and the associated uncertainty valid for both lab performance evaluation studies and reference material certification studies.

## Conclusion

International laboratory anchorage passes through interlaboratory studies organised for dedicated laboratory network implemented on national and international level. Connection between levels is established by expert laboratories members of networks at both levels.

Technical tools already exist to take full benefit of the system developed other are to be developed from the theory and prospects above presented.

ICAR Reference Laboratory Network is the corner of the system and must be enhance with increased worldwide representativeness and competence of members.

## List of references

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