Reliability of Laboratory Results & Laboratory Statistics

Reliability of results is absolutely essential in any laboratory when producing quality data from the lab. Two of the commonly used terms in the production of laboratory data are "accuracy" and "precision." Accuracy refers to the correctness of the given data, while precision is an indication of the reproducibility of an analytical procedure. As defined by the National Bureau of Standards, "Accuracy has to do with the closeness (of data) to the truth, precision only with closeness of readings to one another." An archery target can be used to illustrate the concept of accuracy and precision. If all the arrows are located directly in the center of the bulls-eye, good accuracy and good precision are demonstrated. If all the arrows are clustered in an outer quadrant of the target, good precision, but poor accuracy is shown.

Sources of error in laboratory results can be the result of several reasons, for example, technical error, equipment malfunctions, dirty glassware, or sampling error. The Nutrition Laboratory utilizes basic statistical methods to evaluate precision in the lab analyses. We perform all analyses in duplicate (or triplicate) and calculate the mean (average), the standard deviation, and the coefficient of variation (CV).

Mean ($\bar{x}$): The adding together of the numerical values (x, y, z, etc.) of an analysis and dividing this sum by the number (n) of measurements used.

m = (x + y + z) / n Excel Spreadsheet formula: =average (D2:D3)

Standard Deviation (sd): The most widely used of the deviation averaging techniques because it indicates the confidence intervals for analyzing all data. The sd can be calculated as follows:

1. Determine the mean ($\bar{x}$).
2. Subtract the mean from each measured data item (dx, dy, dz, etc.).
3. Square each difference.
4. Find the average of the squared terms in step 3.
5. Calculate the square root of the average found in step 4 by dividing by one less than the actual number of measurements.

$$s = \sqrt{\frac{dx^2 + dy^2 + dz^2}{n-1}} \qquad Or \qquad s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$$

Excel Spreadsheet formula: =stdev (D2:D3)

Coefficient of Variation (CV): The standard deviation divided by the mean.

$$CV = \frac{s}{\bar{x}}$$

Excel Spreadsheet formula: =F2/E2

Some common nutrition lab analyses and acceptable coefficients of variation (CV) to use as a guideline in evaluating precision.

Analysis	Typical Range in Feedstuffs, %	Acceptable CV, %
DM	80-100	0.5
Ash	0-20	2.0
CP	5-50	2.0
ADF	5-70	3.0
NDF	10-80	3.0
ADL	0-20	4.0
Calcium	0-3	3.0
Phosphorus	0-2	3.0
Ether Extract (Fat)	1-20	4.0
IVDMD	20-80	4.0

Reference

Shugar, G. J., and Ballinger, J. T., Chemical Technician's Ready Reference Handbook. Third Edition, McGraw-Hill, Inc., 1990.