Quality control: A historical journey and the role thereof in oilseeds measurements

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Quality control encompasses a wide range of actions necessary for the successful production, trade and processing of oilseeds. One of the most important quality control factors that runs like a golden thread from production through to final consumption is accurate measurement.

The earliest records of accurate measurement, used to determine the quantity of a product by mass or volume to be traded for another commodity, or later money, were found in the Indus Valley, Mesopotamia and Egypt.

Then versus now

The first measurement standards to compare objects with one another were based on natural products such as carob seeds that have a uniform size, where an artefact object was then manufactured to represent the mass (or volume) of a number of seeds, such as the mina of Babylonia, then dimensions of the body, such as the cubit in ancient Egypt that represents the length of the forearm, and later the dimensions of the earth, or geodetic constants.

In the modern day, in order to measure accurately, a universal measurement system is needed with agreed-upon quantities to be measured, units to measure them in, and measurement standards to globally implement the system.

In 1875, the metric system was introduced to implement such a system – today it is known as the International System of Units (SI) after it was renamed in 1960. So, how did we arrive at this system? It is the result of development over thousands of years.

One of the earliest earth constants to be used, and arguably the measurement standard that has been continuously used the longest, is the time units based on the rotation of the earth. The combined duration of day and night (one rotation of the earth) was designated as a 'solar day' – the time it takes for an observer on the earth to reach the point during the next day where the sun is in the same position in the sky relative to the observer as the day before – of almost 24 hours (the time it takes for the earth to do exactly one rotation is almost exactly 23 hours and 56 minutes, known as the 'sidereal day'). Since the earth also travels around the sun, it takes another four minutes each day to reach the solar day point.

Measurements with Greek origins

The ancient Greeks knew the earth was round and in 240 BC, Eratosthenes who lived in Alexandria, calculated the circumference of the earth. He visited a friend in Syene (modern-day Aswan) and realised that on 22 June at midday, the sun shined directly on his location (the Tropic of Cancer goes through Aswan). The next year, he measured the angle of the sun using the tower of Alexandria, and then measured the distance between Alexandria and Syene (*Figure 1*).

Using this information, Eratosthenes calculated the circumference of the earth to approximately 40 000km, the accuracy of which is remarkable considering that the modern-day measured equatorial circumference of the earth is 40 075km and the meridional or pole-to-pole is 40 008km.

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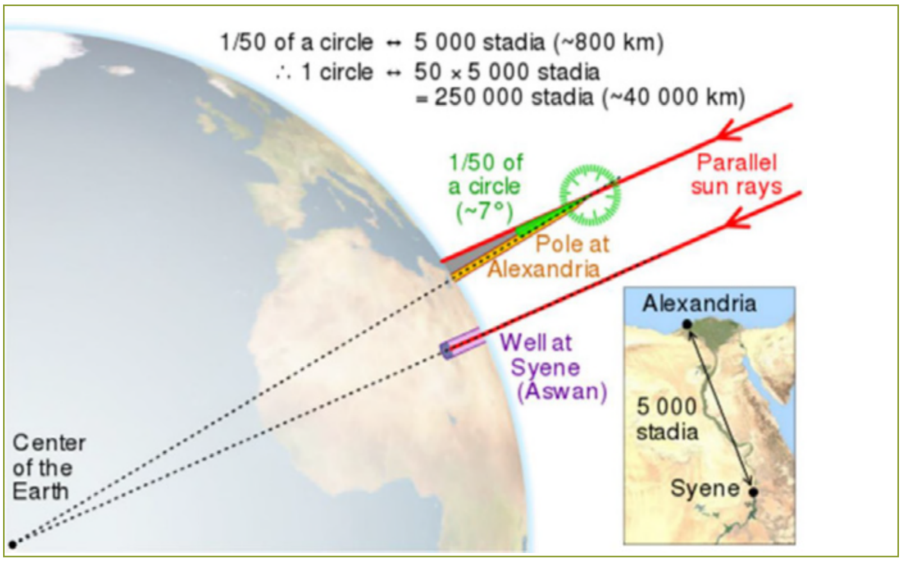
Then, 2000 years later, the Dutch and French used almost the same method to accurately determine the length of a meridian of the earth. They measured the distance from Dunkirk to Barcelona through France using triangulation, and then the methods

Figure 1: Schematic illustration of the calculation of the circumference of the earth.



Dr Tshenge Demana of the Department of Trade, Industry and Competition votes in favour of the redefinition of the SI, at the General Conference of Weights and Measures in 2018. (Photograph: Dr Wynand Louw, president of the International Committee for Weights and Measures)

perfected by the seafarers of their time to determine the latitudes of the two points to calculate the distance from the North Pole to the equator.

They assigned the unit 'metre' to one ten-millionth of this distance. One thousandth of a metre was called a 'millimetre' and mass was then defined in terms of the mass of a 'block of water of 10 x 10mm' weighing 1g, and 1 000g is a kilogram.

In the late 1800s, artefact standards were made of platinum/iridium to embody the metre and the kilogram. Countries that signed the Metre Convention in 1875 obtained Pt/Ir copies of the international prototypes of the metre and the kilogram that were periodically compared with the IPM and IPK held at the International Bureau of Weights and Measures (BIPM) in Paris, France. This system served the world well until the metre was redefined in 1983 in terms of physical constants (speed of light), and the kilogram in 2018 in terms of the Planck constant.

A set of old Babylonian weights, ranging from one mina to three shekels. (Source: www.wikiwand.com/en/Ancient_Mesopotamian_units_of_measurement)

What it means for oilseeds

Today, thanks to modern techniques to realise the measurement units anywhere internationally, we can determine the unit for length to better than 2×10^{-13} (200 millionth of a millimetre) and mass 2×10^{-8} (20 millionth of a gram). Artefacts are still used as 'mass standards', which are calibrated with an unbroken chain to mass standards of increasing accuracy until the most accurate transfer standard is compared to the realisation of the unit, at national or international level. Using such a calibrated standard, weighing instrument accuracy of better than a thousandth of a gram can be achieved for high-accuracy balances.

What does this mean for oilseeds? With our chondrometer, the Kern 222, the density (kilogram per hectolitre) can be determined to 0,1kg/hl. In chemistry, the mass accuracy also allows the preparation of calibration solutions and standards to calibrate measurement instruments for accurate determination of, among others, contaminants and fatty acid profiles.

It also allows the South African Grain Laboratories (SAGL) to analyse the nutritional value of oilseeds to evaluate the quality of a consignment. These primary methods are not only used for accurate measurements to be reported to customers, but also to develop, improve and maintain calibrations on secondary measurement instruments such as NIR and NIT used throughout the oilseeds value chain.