Correct calibration lifts moisture meter accuracy

Several moisture meters are available to check grain moisture content at harvest and before storage. CSIRO Stored Grain Research laboratory scientist Len Caddick discusses some of the factors influencing the accuracy of grain moisture measurements.

Calibrating moisture meters carefully will ensure an accurate measurement at harvest and help maintain grain quality during storage.

Grain moisture content has an important influence on quality changes, which occur during storage.

Deterioration due to insect and mould activity and the rate at which chemical and enzymatic processes take place in grain are strongly related to moisture content.

Other factors influencing grain quality during storage are age or condition of grain at harvest, grain storage temperature and storage time.

Grain characteristics such as hardness and weight are also influenced by moisture content.

Water is present in grain in different states.

Strongly bound water unites with the grain and is difficult to remove, even under high temperatures. This form of bound water is about 5–6 per cent of the total grain moisture content.

Photos: CSIRO Stored Grain Research Laboratory

It is important to accurately measure crop moisture at harvest as the moisture content can significantly affect grain quality during storage.

Water bound by molecular attraction is less tightly held and can be removed using high temperatures.

Loosely bound water held by capillary action accounts for water present in cereal grains at more than 13–14% moisture content.

The moisture can be readily removed using rapid batch or flow-through driers or an aeration system with a high fan flow rate.

A range of portable moisture meters

A range of commercial portable moisture meters is available.

Hand-held meters commonly used to measure grain moisture content in the paddock are conductivity or capacitance-type instruments.

Moisture which is loosely held to grain through molecular attraction or capillary action is the portion measured.

Most portable devices will not read moisture less than 8–9%.

Electrical conductivity or resistance-type instruments measure the ability of a compressed grain sample to conduct a current, relative to its moisture content.

A direct current circuit, often based on a 'wheat-stone bridge' is directed between two electrodes.

Whole seeds or ground meal is placed between the electrodes and the flow of current measured.

Conductivity of grain increases as the moisture content increases.

Capacitance-type instruments measure the ability of a set volume of air and grain to store an electrical charge relative to its moisture content.

Grain is placed between two conducting plates forming a capacitor or condenser and is exposed to high frequency voltage.

The amount of energy absorbed by water molecules in the sample is converted to moisture content.

Meter performance will vary

It is difficult to recommend the best meter for all grain types.

Portable moisture meters need to be calibrated and used in a consistent manner to enable accurate moisture readings.

Grain samples also need to be prepared and presented in a consistent way.

Factors influencing portable meter performance include:

- Temperature differences between the test sample and the measurement cell.
- Temperature differences between ambient conditions and meter.
- Moisture differences between individual kernels.
- Moisture gradients within kernels.
- Grain type, kernel size and varietal differences.
- Maturity stage.
- Weathering, surface texture and moulding.
- Sample size.
- Loading method and changes in packing or bulk density (capacitance-type meters).

At a glance

- Calibrate portable grain moisture meters carefully and use them in a consistent manner to achieve accurate grain moisture measurements.
- Factors influencing moisture meter performance include grain type, kernel size, moisture and temperature differences and loading and packing variations.
- Check meter accuracy before harvest at testing facilities provided by local grain receival agents.

- Variation in compression force (conductance-type meters).
- Variation due to grinding (when required).

Choosing the right meter

Modern moisture meters are designed to compensate (to a degree) temperature influences and to obtain consistent sample results.

Conductivity type meters are designed to apply a uniform compression force.

Any differences in moisture between individual kernels can cause incorrect readings in conductance meters.

Immature green kernels can cause wet spots in the sample, so remove green seeds before testing.

Capacitance meters rely on the operator to pour grain into a test cell in a controlled manner to achieve a consistent packing density. The process has been automated in some models where the grain is dropped into the test cell using a spring-loaded valve.

Capacitance meters are generally calibrated to a packing density of 70% grain to 30% air. Variation from this ratio will affect the result.

The presence of moisture gradients within individual kernels due to re-wetting or drying also impacts on capacitance meter accuracy.

There is a range of portable conductance and capacitance meters available to measure grain moisture in the paddock. The moisture meters all need to be calibrated and used in a consistent manner to enable accurate moisture measurements.

Capacitance meters measure moisture present on the grain surface and in air between kernels.

Conductance meters are better suited to measuring grain moisture where significant moisture variation within kernels is likely to be a problem.

Crop variability affects accuracy

Variability of grain moisture content within and between plants in a ripe crop can make accurate measurement difficult.

The variability is likely to be highest during early harvest and for large-seeded crops such as chickpeas, field peas, lupins and maize.

Differences in moisture between the outer and inner portions of the grain due to re-wetting caused by heavy dew or rainfall also will affect accuracy.

Increasing the number of grain samples will provide a better profile of the overall moisture content of a crop.

Improve the accuracy of portable meters by placing grain into sealed bags and standing them together with the portable meter in a shaded location for 30 minutes before testing.

Meter calibration takes time

Calibration of a portable meter is not difficult but can be time consuming.

Take advantage of the testing facilities provided by local receival agents to check the accuracy of portable meters before harvest.

Near infrared transmittance (NIT) or reflectance (NIR) systems are now used extensively by commercial grain storers to measure grain moisture content.

Results from these systems can be compared with values obtained on a portable meter to determine the difference in moisture content readings.

Collect 4–5 composite samples from different parts of a paddock, set them aside in a shaded area for about 30 minutes, then test them through the system used by the local grain receival agent.

Check the samples at the same time using the portable meter at the receival site, preferably under similar conditions.

There could be variation in measurement between the portable meter and NIT or NIR instrument. The magnitude of the difference also may vary across a given moisture range.

Using grain samples from the paddock to calibrate a portable meter against a near infrared system will achieve a more accurate result than relying on the calibrations offered by distributors of portable devices.

TABLE 1 Meter performance

Moisture meter	Average difference (%)
Graintec HE 50	0.10
Graintec HE 60	0.17
Marconi TF 933C	0.30
Kett Riceter J308	0.23
Kett PM400	0.39

Note: The results are a comparison of the difference in grain moisture content between paddock and laboratory measurements.

Source: CSIRO Stored Grain Research Laboratory.

Testing meter accuracy

CSIRO Stored Grain Research Laboratory assessed a range of portable moisture meters during the 2000 sorghum harvest in northern New South Wales.

The conductance-type moisture meters used in the study were the Kett Riceter J308, Marconi TF933C and Graintec HE50 and HE60. The Kett PM400 was the only capacitance meter evaluated.

Sorghum was coarsely hand ground using a coffee mill for use in the Marconi meter. Sorghum used in the Graintec HE60 meter was coarsely serrated using a mill supplied as part of the kit. Whole grain was used in all other devices.

The calibration of each device was not adjusted from the manufacturer's setting.

The Graintec HE50 and HE60 produced the most consistent results between the paddock and laboratory, showing a carefully calibrated device used in a consistent manner is likely to produce accurate results under paddock conditions (see Table 1). The Kett PM400 showed the widest variation between paddock and laboratory testing.

Capacitance-type moisture meters are prone to errors due to variation in packing density and moisture within kernels. Handling or excessive vibration of the unit during sample loading is likely to influence the result.

Measurement of sorghum received from rapid dryers or harvested during early morning or late afternoon also can cause errors.

The Kett PM400 provided accurate, consistent readings under controlled laboratory conditions, where sorghum moisture had been equilibrated (evened out).

Near infrared technology

The accuracy of NIT and NIR grain moisture tests depends on extensive information being incorporated into a calibration set. These devices measure the amount of near infrared energy absorbed by the grain sample.

NIT instruments measure absorption as the difference in energy transmitted through a sample and NIR instruments measure absorption as the difference in energy transmitted into but reflected by a sample.

Different grain components have different absorption characteristics.

Water is a strong absorber of near infrared energy and the higher the grain moisture content, the higher the amount of near infrared energy absorbed.

But factors that affect accuracy include grain type and variety, protein, carbohydrate and oil content, ambient temperature and humidity, hardness and colour and seasonal effects such as moulding, tainting and hue changes, frosted and pinched grains and weather damage.

Contemporary NIT and NIR systems have a universal calibration data set incorporated and used along with regional- and State-generated calibrations, which have been developed over several seasons.

The calibration data compensates for factors, apart from moisture, which absorb near infrared energy or influence the performance of the system.

But they are not infallible, so calibration sets can be readily adjusted to account for local grain conditions.

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