Grain moisture

– guidelines for measurement

HGCA

Why moisture matters

Moisture content is critical from harvest, through storage, to final sale of cereals and oilseeds. If moisture is too high, there is a risk of quality reduction, or even crop loss in store. On the other hand, excessive drying is wasteful and can lead to reduced returns.

Balancing these opposing risks is not easy due to the variable nature of grains within a bulk and the inherent difficulties of measuring grain moisture accurately.

Cereals and oilseeds which are too moist in storage can be subject to:

- **mould growth and mycotoxin production**
- **mite infestations, especially in rapeseed**

- **heating due to moulds and mites**
- **sprouting.**

Grain which is over-dried before, or during, storage can result in:

- **splitting and cracking**
- **impaired quality, particularly in rapeseed**
- **wasteful energy use.**

Grain contracts specify moisture content which, if not met, will result in penalties.

Accuracy and consistency

Accuracy – a measurement of how closely a meter reading matches the oven test. Accuracy is important to avoid spoilage or mycotoxin formation.

Consistency – achieved when multiple tests of the same sample produce very similar results. Meter maintenance and best practice help ensure consistent readings.

Assessing moisture content on the farm

Moisture meters and probes, available for farm use, measure an electrical property related to moisture content, rather than grain moisture itself. Meters and probes rely on an inbuilt calibration between moisture and either electrical capacitance or resistance.

Meters and probes are calibrated against oven-based moisture determinations.

All **probes** and **capacitance meters** use whole grain samples.

Most **resistance meters** use a ground sample.

Accuracy: ±0.5% at best

Meters are calibrated to operate most accurately within a specific moisture range, typically 11–20%.

Causes of variation:

- inadequate grinding, if required
- temperature differences between grain and meter/probe
- poor maintenance
- damaged probe or measuring cell
- depth of probe insertion
- grain moisture outside range of meter/probe
- contaminants, eg soil, screenings
- out of calibration.

Measuring moisture content in the laboratory

The most accurate method of measuring grain moisture content is the **standard oven-based test**, which uses an ISO-specified protocol to dry a prepared sample of ground grain in a special laboratory oven (ISO 712).

The weight lost during drying is used to calculate the moisture of the sample.

Accuracy: within 0.15%

Causes of variation:

- unrepresentative grain sample
- inadequate grinding
- incorrect oven drying time
- uneven oven temperature.

Managing moisture: project findings

These guidelines are partly based on an HGCA-funded project on grain moisture measurement, led by the Central Science Laboratory (CSL) using wheat and barley from the 2006 and 2007 harvest seasons. They also draw upon broader experience from research and practice.

The project aimed to:

– evaluate differences in measurement over the drying and storage periods

– assess variation between wheat varieties

– check consistency and accuracy of meters and quantify common errors in usage.

The project, conducted in collaboration with meter manufacturers, involved:

– surveying the views and practices of 158 farmers

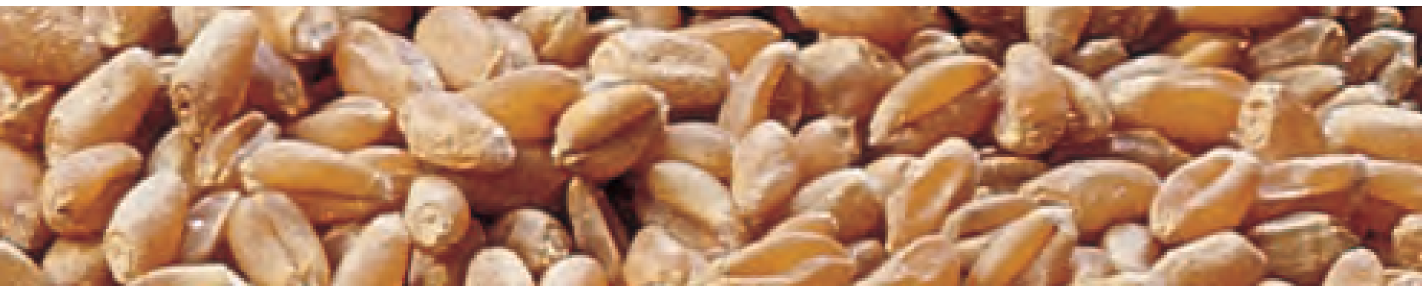
– investigating specific issues on farm

– comparing meters in laboratory conditions.

Relevant results from the project are summarised below.

Project finding	Inference
Moisture meters - overview	
Many farmers and storekeepers did not have their meters calibrated, or maintained, regularly.	Ensure calibration and maintenance is undertaken each year. Ideally, return annually to manufacturer.
Laboratory and on-farm tests gave equally accurate and consistent results for all meters tested – both capacitance and resistance.	Type of meter is not an issue.
Meter testing	
Meter tests showed that for wheat and barley:	
– at around 15%, meters were usually within ±0.5% of the oven test	It is prudent to treat meter readings conservatively. In the project, farmers who allowed a 0.5% safety margin never had claims for excess moisture.
– at 18% or above, meters tended to under read by as much as 1%	Be especially wary of results on moist grain and the increased risk of mycotoxin contamination.
– repeat testing of the same sample gave meter readings within ±0.3%	Take sufficient sub-samples to achieve a representative composite sample (see *Grain sampling – a farmer's guide*, 2003, HGCA).
– sample variation resulted in discrepancies of up to ±1%	
– poor operator practice resulted in errors of up to ±1%	Always follow instructions on meter use.
– moisture content variability increased in freshly-harvested grain, even within well-mixed samples.	Expect greater variability with freshly-harvested grain than with grain stored for some time.

Project finding	Inference
Sample preparation	
Sample variability had the greatest influence on consistency.	Obtain a well-mixed sample that is representative of the bulk to be tested.
Capacitance meters	
Readings from freshly-dried grain were 0.4% lower than same samples re-analysed a week later.	Allow for an apparent 0.4% moisture content increase when analysing freshly-dried grain with a capacitance meter.
Readings from a meter at an angle of 30 degrees were 0.4% lower than from a level meter.	Use meters on level surfaces.
Grinding samples for resistance meters	
Errors with finely-ground samples were greater (±0.6%) than those with coarsely-ground samples (±0.3%), when both were compared with oven test results.	Coarse grinding is sufficient and further grinding results in less accuracy.
Readings were 1% lower when a worn grinder was used.	Ensure that grinder is properly maintained.
Inadequate compression resulted in lower readings.	Compress ground sample as specified.
The effect of temperature	
Errors of up to ±1% occurred when sample and meter temperatures differed by 15°C.	Allow sufficient time for meter and grain temperatures to equilibrate.
Variety or variety type	
No differences were found using four meters to compare 20 wheat varieties – 13 with hard and 7 with soft endosperm.	Use one calibration for UK wheat only.
Where a meter had two calibrations for wheat the soft calibration was the most accurate for both varieties.	
Moisture probes	
Probes were not as accurate as meters in the tests. However, probes gave consistent and reliable results.	Use probes to rapidly monitor the moisture content of grain within a bulk; not in place of meters to assess moisture content of samples.
Both types of probe – resistance and capacitance – were equally accurate, but resistance probes only gave a steady reading once probe and grain temperatures had stabilised after a minute or more.	Allow time for temperature of grain and probe to stabilise.
Depth of insertion affected both types. Low readings resulted at less than 0.5m depth.	Insert probe to the correct depth.



Practical pointers

Meter and probe maintenance

Routine maintenance is important for good practice and to comply with farm assurance protocols.

Return to manufacturer for full service	**– Most thorough, covering all aspects of meter** **– Cost: £50-70**
Attend a moisture meter clinic	**– Checked over range of moistures and commodities** **– Complies with assurance schemes** **– Only assesses measurement** **– Less thorough than manufacturer**
Test against a buyer's sample	**– Improved agreement with buyer** **– Limited range of test samples**

When checking a moisture meter/probe it is important to:

- Test samples before harvest if possible to confirm meter function.
- Only use samples from a TASCC-approved or UKAS-accredited laboratory.
- Check against several samples covering at the very least 14% to 16% moisture.
- Ideally take meter to location where samples were prepared.

On-farm adjustments are not recommended. DIY adjustments usually increase errors.

Preparing samples

To minimise errors a well-mixed, representative sample should be taken. Care should be taken to avoid contaminants, eg soil or screenings.

The effect of temperature

Allow meter and grain sample to achieve the same temperature – usually a few minutes. This is particularly important when meter is stored in a cooler/ warmer environment than the grain.

Allow a longer equilibrium period when using a probe in grain recently placed in store.

Getting the best out of your meter

- Select correct calibration for crop to be tested.
- Keep measuring cell clean and free from contamination.
- Always allow a safety margin, as errors are frequently ±0.5% and much more in very wet, very dry or freshly harvested grain.
- Assess your meter function over a period:
  - Do results change after harvest?
  - Does it read high or low with very wet grain?
  - How do results with your meter compare with those on the same samples sent to merchant(s)?
- If errors consistently occur, have your meter checked. If in doubt, or errors are large, return meter to the manufacturer.
- For trading without penalties allow a margin of safety.

Remember, moisture measurement is not an exact science.

Loading capacitance meters

Use loading devices supplied. It is very important to fill meters with the specified quantities of grain and to keep the meters level.

Grinding samples for resistance meters

Clean and lubricate compressor plunger threads daily. Check grinder regularly for wear.

If a specific grinder is not supplied with the meter, crack grains into two or three pieces. Acceptable results can be achieved with a coffee grinder, but avoid grinding too finely as moisture may be reduced.

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Further information

HGCA publications

Grain sampling – a farmer's guide (2003)

Grain sampling from field to buyer – understanding variation (2004)

The grain storage guide, 2nd edition (2003)

Project Report 426 (2008) Research to develop practical user guidelines to maximise the accuracy of moisture meters

British and International Standards

Standard number	Title	International equivalent
BS 4317 Part 3 (1999)	Determination of moisture content of cereals and cereal products (routine reference method)	ISO 712
BS 4317 Part 26 (1991)	Measurement of temperature of grain during bulk storage	ISO 4112
BS 6279 Part 2 (2001)	Storage of cereals and pulses. Practical recommendations	ISO 6322-2

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