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Evaluation Report 181

Cera-Tester Type 107-10 Grain Moisture Tester

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

CERA-TESTER TYPE 107-10 GRAIN MOISTURE TESTER

MANUFACTURER:
A/S N. Foss Electric
39 Roskildevej - DK - 3400 Hillerod
Denmark

DISTRIBUTOR:
Foss Electric Canada Ltd.
700 Campbell Street
Cornwall, Ontario
K6H 6C9

RETAIL PRICE:
$350.00 (June, 1981, f.o.b. Lethbridge).

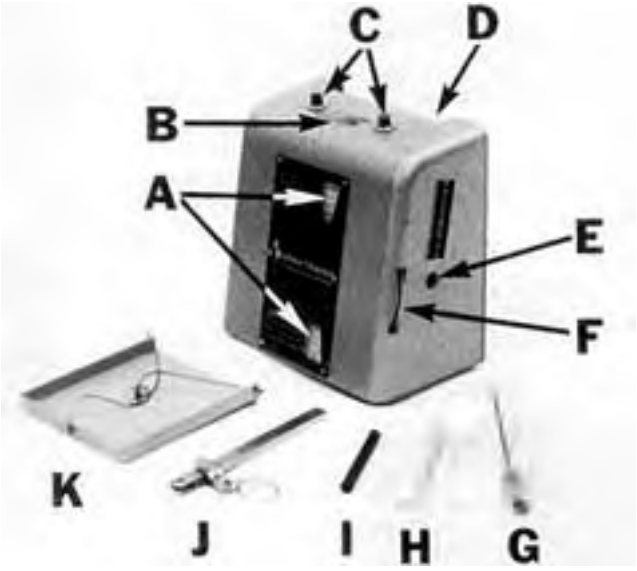

FIGURE 1. Cera-Tester Type 107-10 Grain Moisture Tester: (A) Dial Reading, (B) Meter Indicator, (C) Control Buttons, (D) Grain Cell, (E) Calibration Adjustment, (F) Dial Adjustment, (G) Cleaning Brush, (H) Thermometer, (I) Calibration Trimming Key, (J) Balance, (K) Weighing Tray.

SUMMARY AND CONCLUSIONS

Overall performance of the Cera-Tester grain moisture meter was very good in wheat, barley and rapeseed. No dial scale was provided for oats. A PAMI calibration for oats, using the normal scale, is provided in the report. This compares to an overall performance of very good in wheat and barley and excellent in rapeseed for the PAMI reference meter, which is similar to meters commonly used in most prairie grain elevators.

Average meter error varied from 0.6 to 0.4% high in wheat, 0.3% high to accurate in barley, and from 0.3 to 0.4% low for rapeseed over a range of moisture contents from 12 to 20% for cereal grains and 8 to 15% for rapeseed. Meter uncertainty varied from excellent in wheat and good in barley to very good in rapeseed. Meter repeatability varied from very good in wheat and barley to excellent in rapeseed.

The range of moisture contents of greatest concern for cereal grains varies from 12 to 20% and for rapeseed from 8 to 15%. The Cera-Tester was capable of measuring moisture contents throughout these ranges.

The meter was easy to operate and a moisture measurement could be made in less than one minute. The meter was durable and easily transported for field use.

As with most moisture meters, results depended on grain variety, the geographic location in which the grain was grown and many other variables. It is recommended that the user annually check a few samples against the meter used at his local elevator to determine a suitable Correction factor. The instruction manual provided was clear and easy to understand.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to the grain tray to improve ease of sample handling.
2. Placing operating instructions directly on the meter body for convenient field reference.

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Project Engineer: R. K. Allam

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We accept the fact that sample weighing could be improved. However, for ease and simplicity of operation in all the countries in which the Cera-Tester is sold, the pan has been found to be the most reliable method of weighing.
2. This recommendation will be taken under consideration.

NOTE: This report has been prepared using SI units of measurement. A conversion table is given in APPENDIX IV.

GENERAL DISCRIPTION

The Cera Tester Type 107-10 determines grain moisture content using the capacitance principle. This principle is based on the change in the dielectric properties of grain with changes in moisture content.

Moisture content of the sample is read directly off the meter dial for most common grains grown on the prairies. The Cera-Tester did not include a calibration for oats. Meter dial readings are corrected for temperature differences using the thermometer, calibrated in per cent moisture, located at the back of the meter.

Sample size for all grains is 100 g and is weighed on a hand-held balance beam scale supplied with the meter.

The meter is supplied with a vinyl carrying case complete with carrying strap for field use. Also supplied are a grain tray, cleaning brush and a calibration trimming key.

The meter operates on six, 1.5 V transistor batteries. Detailed specifications are found in APPENDIX I while FIGURE 1 shows major components.

SCOPE OF TEST

The Cera-Tester was evaluated in wheat, barley, oats and rapeseed. Meter readings were compared to moisture contents obtained using the American Association of Cereal Chemists oven method. This method is also used by the Canadian Grain Commission Research Laboratory. In addition, performance was compared to that of the PAMI reference moisture meter.[1]

Samples of several different varieties of each grain grown in several locations were used to determine meter performance. The Cera-Tester was used with artificially tempered grain, naturally tempered grain and with field samples of several grain varieties at various stages of maturity, which had not been subjected to rain after windrowing.

The moisture content of each grain sample was measured five times with the meter. In total, over 550 measurements were made with the Cera-Tester. All results in this report are expressed on a per cent wet-weight basis, consistent with common grain practice.

The Cera-Tester was evaluated for ease of operation, quality of work and suitability of the operator's manual.

RESULTS AND DISCUSSION

EASE OF OPERATION

Moisture Measurement: The Cera-Tester was easy to operate. The circuitry was fully transistorized, requiring no warm-up period. It was necessary to accurately weigh the sample before determining its moisture content. The meter required a level surface for best accuracy. Temperature compensation was made by using

[1]*The PAMI reference moisture meter is a Labtronics model 919, similar to the moisture meters used in most prairie grain elevators. Detailed results for the reference moisture meter are presented in Evaluation Report E2379H.*

the thermometer attached to the back of the meter. This thermometer was calibrated in percent moisture to be added or subtracted to the meter dial reading. In total, it took about one minute to complete a moisture measurement.

The meter dial readings for wheat, barley and rapeseed were easily read to the nearest 0.1% moisture content. No calibration for oats was provided.

Calibration was necessary when first turning the meter on and about every hour thereafter if the meter was used continuously. Calibration adjustment was easily made with the calibration trimming key provided.

The grain sample tray provided with the meter was shallow, making it somewhat inconvenient for sample weighing and handling. Grain spillages were common during sample weighing if the tray was not filled carefully and evenly. It is recommended that the manufacturer consider modifications to the grain sample tray to eliminate this inconvenience.

The Cera control buttons were spring loaded and had to be manually depressed for meter readings and calibrations. This prevented accidental battery failure since it was impossible to leave the meter turned on after use. A battery test was provided for convenient battery testing. The meter batteries lasted throughout the evaluation period. The batteries were readily obtainable and easy to replace with the use of a screwdriver.

Field Use: The Cera-Tester was provided with a vinyl carrying case. The meter and accessories all fit into the case for convenient field transport. Moisture measurements could be made in the field providing a flat surface protected from wind was available.

QUALITY OF WORK

Weighing Accuracy: The hand held balance scale supplied, was accurate to 0.1 g when care was taken to achieve an exact balance. A sample size of 100 g was used for all grains. Careful weighing with the hand-held balance resulted in the required sample weight accuracy to obtain accurate moisture content measurements. However, pouring grain into the tray until the balance tipped, resulted in samples being overweight by as much as 5 g and a resulting 1.1% error in moisture content. Accurate weighing in the field required a calm environment. Accurate sample weights are necessary to obtain accurate moisture content measurements.

Temperature Compensation: Temperature compensation with the Cera-Tester was accomplished by using the thermometer attached to the meter back plate. The thermometer was calibrated in per cent moisture content to be added or subtracted to the meter dial reading. Temperature compensation was accurate.

Measurement Range: The range of moisture contents of greatest concern for cereal grains varies from about 12 to 20% and for rapeseed from 8 to 15%. These ranges include dry, tough and damp stages. The Cera-Tester was capable of moisture measurement throughout these ranges.

The scales on the Cera-Tester meter dial indicated that it was capable of measuring moisture contents ranging from 11.0 to 21.0% in wheat, 7.0 to 25.0% in barley and from 6.0 to 18.0% in rapeseed. The Cera-Tester was evaluated with samples ranging from 9.4 to 30.1% in wheat, 10.2 to 30.4% in barley, 11.0 to 22.5% inoats and 6.9 to 16.7% in rapeseed.

Accuracy: FIGURE 2 presents accuracy results for the Cera-Tester in wheat. It shows the error (difference between indicated moisture content and oven moisture content) over the meter measurement range. The best-fit line gives the average results for eight samples of Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in the laboratory), together with eight samples of naturally tempered Neepawa wheat from Lethbridge (originally dry windrows which had been rained upon) and nine samples of Neepawa wheat from Lethbridge which had received no rain while maturing in the windrow. Meter readings varied from 0.6 to 0.4% high over the range of moisture contents from 12 to 20%. At 14.5%, the upper limit for dry wheat, the Cera-Tester read 0.6% high. This compares to a reading of 0.5% high for the PAMI reference meter at 14.5% in the same grain.

FIGURE 3 presents accuracy results for the Cera-Tester in barley. The best-fit line gives the average results for 18 samples of tempered Betzes barley, 11 samples of naturally tempered Gait barley and eight samples of Gait barley which had received no rain while maturing in the windrow. Meter readings varied from 0.3% high to accurate in the range of moisture contents from 12 to 20%, respectively. At 14.8%, the upper limit for dry barley, the Cera-Tester read 0.2% high. This compares to a reading of 0.1% high for the PAMI reference moisture meter at 14.8% in the same grain.

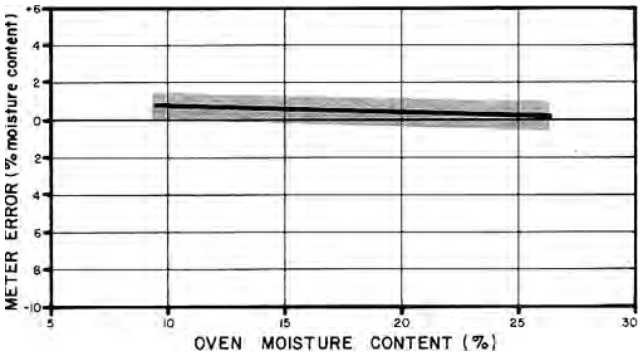

FIGURE 2. Accuracy of the Cera-Tester in Wheat.

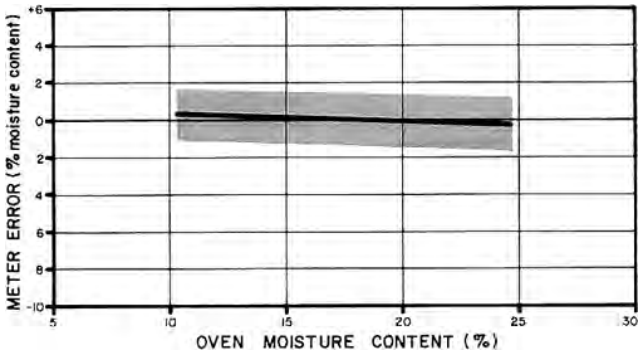

FIGURE 3. Accuracy of the Cera-Tester in Barley.

No manufacturer's scale was provided on the meter dial for oats. PAMI developed a calibration for oats using the normal scale on the meter dial. Calibration results for the Cera-Tester in oats are given in FIGURE 4. The best fit line gives the average results for 15 samples of artificially tempered Sioux oats and four samples of naturally tempered oats.

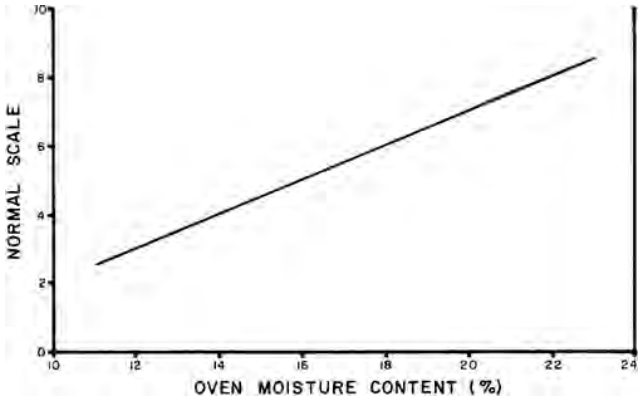

FIGURE 4. PAMI Calibration in Oats using the Normal Scale.

The best-fit line for the Cera-Tester in rapeseed is given in FIGURE 5. This figure gives the average results for 16 samples of artificially tempered Argentine rapeseed and four samples of naturally tempered rapeseed. Meter readings varied from 0.3 to 0.4% low over the entire range of moisture contents from 8 to 15%, respectively. At 10.5%, the upper limit for dry rapeseed, the Cera-Tester read 0.3% low while the PAMI reference meter for the same grain samples was accurate.

Uncertainty: The shaded belts on FIGURES 2, 3 and 5 are the 95% confidence belts. These belts can be used as a measure of meter uncertainty since they represent the region in which 95% of the test results can be expected to occur. A wide belt indicates wide scatter and measurement uncertainty, whereas a narrow belt shows good meter certainty. Uncertainty of the Cera-Tester was excellent in wheat, good in barley and very good in rapeseed. This compares to an uncertainty of very good in wheat and barley and excellent in

rapeseed for the PAMI reference moisture meter.

Data showing further statistical interpretation are presented in APPENDIX II.

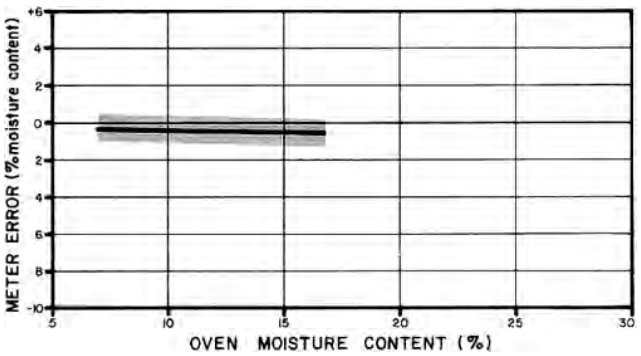

FIGURE 5. Accuracy of the Cera-Tester in Rapeseed.

Repeatability: Repeatability is a measure of how consistently a meter gives the same reading when the same grain sample is tested several times. If operator error or instrument error result in different readings with repeated measurements of the same sample, then the repeatability is poor.

Repeatability of the Cera-Tester was very good in wheat and barley and excellent in rapeseed. This compares to a repeatability of excellent in wheat and rapeseed and very good in barley for the PAMI reference moisture meter.

Errors from Crop Variables: The dielectric properties of grain vary with grain variety, kernel size, geographic location, maturity, weathering, artificial or natural drying, tempering (whether or not a dry windrow was re-wetted with rain) and other factors depending on the year the grain was harvested. The manufacturer's moisture scales are an attempt to accurately represent the average properties for one grain variety. It is difficult to accurately predict the dielectric properties of all varieties of grains grown in the prairies and to prepare an appropriate calibration chart.

To illustrate this point, FIGURE 6 and APPENDIX II show the average best-fit lines for three separate groups of spring wheat samples tested with the PAMI reference moisture meter. The upper line is for 20 samples from a field of Neepawa wheat at Humboldt, Saskatchewan in 1976. The windrows had received rain and samples were taken as the wheat dried in the field. Meter readings varied from 0.9 to 1.0% high over a range of moisture contents from 12 to 20%.

The middle line is for 34 samples of Neepawa wheat from Lethbridge, Alberta in 1979, 12 of which were naturally tempered, nine of which had received no rain while maturing in the windrow and 13 of which had been artificially tempered. Meter readings for these samples were 0.5% high over a range of moisture contents from 12 to 20%.

The lower line is for 14 samples of spring wheat from Lethbridge, Alberta in 1976. These samples had received no rain while maturing in the windrow. Meter results varied from 0.3 to 0.2% high over a range of moisture contents from 12 to 20%.

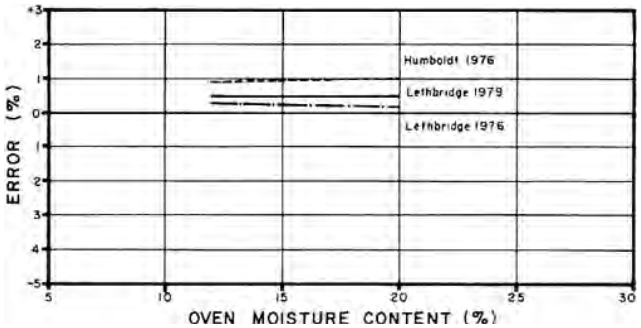

FIGURE 6. Deviations of Meter Readings for the PAMI Reference Moisture Meter in Three Different Groups of Wheat.

It can be seen from the above results that though the Pami reference moisture meter is a relatively accurate instrument, it is very difficult for a manufacturer to prepare a calibration chart with suitable correction factors to suit all the possible combinations for one type of grain. The measurements involved would be time consuming and would defeat the purpose of a portable grain moisture meter.

The Cera moisture tester was similarly affected by these same variables. It is, therefore, recommended that the owner annually check the results of his moisture meter against the moisture meter used at his local elevator. Comparing only a few samples should give enough information to correct meter readings.

DURABILITY

A loose ground connection and loose component mounting screws inside the meter caused erratic meter needle movement whenever the meter was lightly bumped or jarred. Repairs were made to eliminate these problems.

OPERATOR'S MANUAL

The manual was clear and concise and contained all the information necessary for grain moisture measurement. It is recommended that the operating instructions also be printed on the meter body for convenient field reference.

ACKNOWLEDGEMENT

Thanks are extended to Lethbridge area farmers for assistance in collecting grain samples and the Agriculture Canada Research Station, Lethbridge, for the use of their stationary thresher.

APPENDIX I
SPECIFICATIONS

Model:	Cera 107-10
Serial Number:	2475-296
Electrical Power Requirements:	6, 1.5 V transistor batteries
Overall Height:	210 mm
Overall Width:	200 mm
Overall Length:	130 mm
Total Weight (in carrying case):	3.3 kg
Principle of Operation:	Capacitance
Sample Weight:	100g

APPENDIX II
Statistical Significance of Moisture Meter Results

The following data are presented to illustrate the statistical significance of the moisture meter results shown in FIGURES 2 to 6. This information is intended for use by those who may wish to check results in greater detail.

In the following table, M = the reading of the Cera-Tester in per cent moisture, wet basis, T = the moisture content of the sample in per cent moisture, wet basis, as determined by the American Association of Cereal Chemists oven method and N = the dial reading on the Cera-Tester "normal scale" used for meter calibration in oats. Sample size refers to the number of grain samples used. Each meter sample represents the average of five meter readings on that sample.

Grain Type	Fig. No.	Regression	Correlation Coefficient	Standard Error	Sample Size	Sample Mean
CERA-TESTER						
Wheat	2	M = 0.98T + 0.84	0.99	0.39	25	16.44
Barley	3	M = 0.96T + 0.79	0.99	0.66	37	18.02
Rapeseed	4	M = 0.98T - 0.10	1.00	0.30	20	10.91
Oats (Calibration)	5	M = N/0.50 + 5.88	0.99	0.23	19	4.86
PAMI REFERENCE METER						
Wheat, Humboldt (1976)	6	M = 1.01T + 0.81	1.00	0.38	20	18.26
Wheat, Lethbridge (1976)	6	M = 1.01T + 0.42	1.00	0.38	34	17.32
Wheat, Lethbridge (1979)	6	M = 0.98T + 0.58	0.99	0.32	14	13.87

APPENDIX III
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(f) unsatisfactory

APPENDIX IV
CONVERSION TABLE

1 millimetre (mm)	= 0.04 inches (in)
1 gram (g)	= 0.04 ounces (oz)
1 kilogram (kg)	= 2.2 pounds (lb)

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