Evaluation Report No. E0175B
Printed: February, 1977
Tested at: Lethbridge
ISSN 0383-3445

Evaluation Report 2

Qwik-Test Portable Moisture Tester

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

Qwik-Test Portable Moisture Tester

Manufacturer:

Agridustrial Electronics Inc.
Bettendorf, Iowa 52722
U.S.A.

Distributor:

Dickey-john Corporation
Auburn, Illinois 62615
U.S.A.

Retail Price:

$129.00 (March 1977, f.o.b. Bettendorf, Iowa)

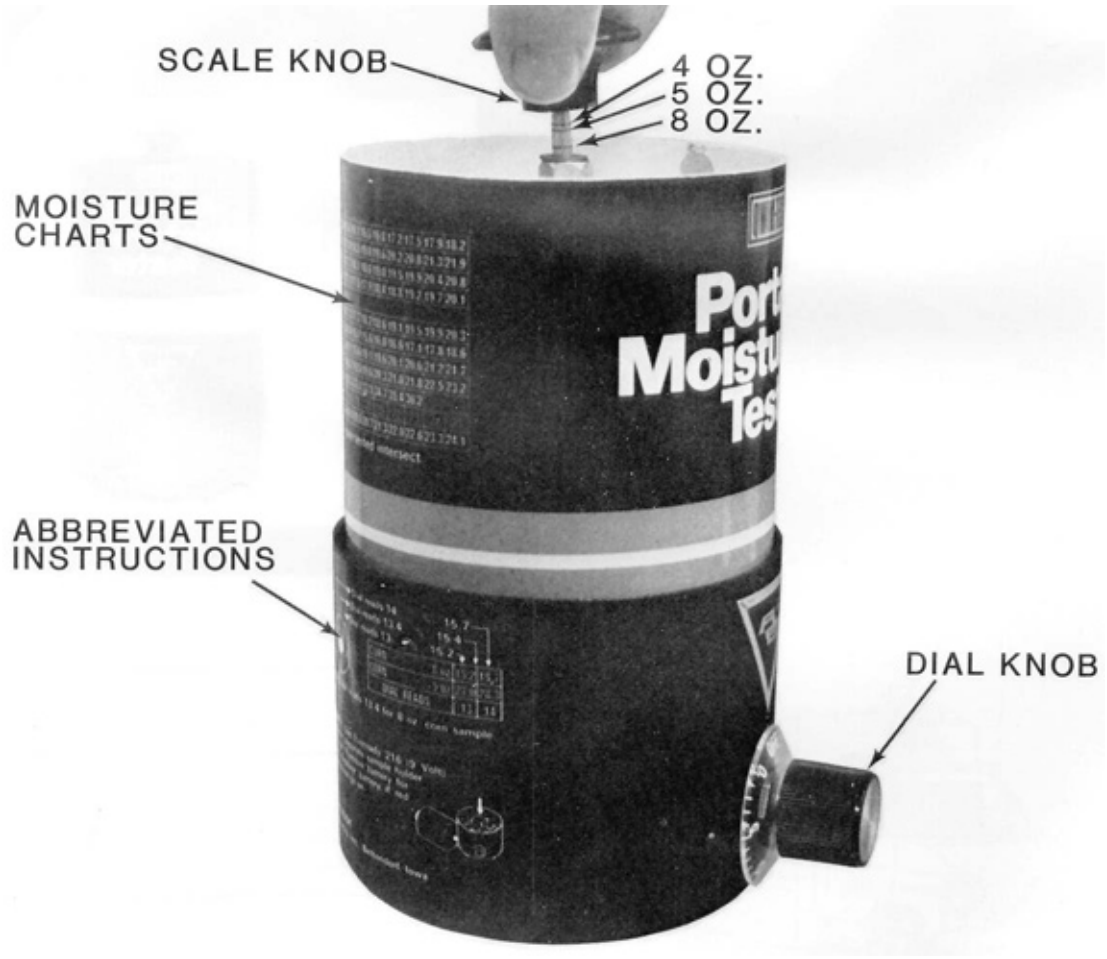

Figure 1. Detailed View of Qwik-Test Portable Moisture Tester.

Summary And Conclusions

Accuracy of the Qwik-Test portable moisture tester was *fair,* in wheat, *very good* in barley and *fair* in oats. Meter accuracy could be improved by modification of the calibration charts for wheat. The accuracy of the meter was limited by the accuracy of the spring scale and the degree of grain packing.

Meter repeatability was *good* in wheat and oats and *very good* in barley.

Meter readings varied from 2.4 to 1.7% high in wheat, 0.3% high to 0.4% low in barley and 0.4% high to 2.3% low in oats, over a range of moisture contents from 12 to 20%.

No moisture charts were provided for rapeseed, but test results indicated that the Qwik-Test could be used for rapeseed.

The meter was simple to operate and a moisture measurement could be made in less than one minute if both sample and meter were at the same temperature. An additional two minutes were required if temperature compensation was need.

Meter readings were dependent upon grain variety, 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 by his local grain elevator to determine a suitable correction factor.

The meter was durable and easily transported for field use.

The instruction manual was clear and concise except for the method of meter separation for battery replacement.

Recommendations

It is recommended that the manufacturer consider:

1. Improving sample weighing accuracy.
2. Providing moisture content charts for rapeseed and other oilseeds.
3. Modifying the calibration charts for wheat to improve meter accuracy.
4. Clarifying instructions in the instruction manual to indicate how to replace the battery.
5. Modifying the calibration charts using S.I. units to be consistent with the Canadian metric conversion program.
6. Replacing the moisture content readings for wheat shown on the outside of the meter with those for Canadian hard red spring wheat for meters sold in Canada.

Chief Engineer -- E.O. Nyborg
Senior Engineer -- E.H. Wiens
Project Engineer -- D.R. Stafford

The Manufacturer States That

With regard to recommendation number:

1. The meter is designed to sell at a reasonable price. If the scale was made more complicated, the unit would be more expensive. If care is taken using the unit, good accuracy can be obtained.
2. Charts are available from the manufacturer for cottonseed, flax, millet, mustard, rapeseed, timothy and buckwheat.
3. New charts for hard red Canadian spring wheat would be constructed if enough samples of the grain were made available to Qwik-Test.
4. Clarification of the instructions on battery removal are being made in the new printing presently being carried out.
5. When a new printing is made for outside of canister, the ounces will be changed to grams to conform to SI Units.
6. If sales in Canada become significant, the hard red Canadian spring wheat chart will be placed on the canister.

General Description

The Qwik-Test grain moisture tester determines moisture content using the capacitance principle. It measures the dielectric constant which changes with the moisture content of the grain.

The dial of the meter is divided in increments of 0.2 over a range from 0 to 25. Moisture content is determined from the dial reading by referring to charts. Moisture content charts for sunflower, wheat, rye, barley, rice, oats, sorghum, soybeans, corn and popcorn are listed on the outside of the meter. Moisture contents for 17 other grains are listed in the instruction manual. Charts are not supplied for flax or rapeseed.

A grain sample of 226.8 g (8 oz) is weighed in the spring loaded scale which is an integral part of the moisture meter. Temperature compensation is automatic and built into the meter.

The meter operates on a 9 volt Eveready No. 216 transistor battery.

Complete specifications are found in Appendix I.

Scope Of Test

The Qwik-Test was used to determine moisture contents in wheat, oats and barley and was calibrated for rapeseed. Meter readings were compared to moisture contents obtained using the Canadian Grain Commission Research Laboratory oven method. All moisture contents were expressed on a percent wet basis as used in all grain elevators.

For each grain, samples of several different varieties, grown in several locations, were used to determine meter characteristics. The meter was used with artificially tempered grain (dry grain which was moistened in the laboratory and allowed to stabilize before moisture measurement) and with naturally tempered grain (originally dry windrows which had been rained upon and were being dried naturally). It was also used 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 500 measurements were made with the Qwik-Test.

The meter was evaluated for ease of operation, accuracy, repeatability, durability and portability.

Results And Discussion

EASE OF OPERATION

The Qwik-Test was a hand held meter which was simple to operate. The meter was "instant on" so no warm-up period was required. The moisture content of a grain sample could be determined in less than a minute if both meter and sample were at the same temperature. If the meter and sample were at different temperatures an additional two minutes was required for the automatic temperature compensation circuit to react.

The dial was easily read to the nearest 0.2 division which resulted in a moisture content reading to the nearest 0.1%. Error due to reading the dial from an angle (parallax) was insignificant.

Four batteries were required during the test, in which approximately 500 samples were tested. The current draw and power consumption of the Qwik-Test was relatively high, requiring the battery to be at its rated voltage to get accurate readings. The meter could be inadvertently left on, which would result in very early battery failure. The battery was easily replaced and readily obtainable. Instructions on meter disassembly, for battery replacement, were not included in the instruction manual.

ACCURACY

Sample Weight: A spring scale was built into the meter to obtain sample weight. The actual weight of the indicated 226.8 g sample was 227.3 g when the meter was new. This weighing error caused only a 0.1% error in moisture content. At the end of the test the indicated sample weighed 226.6 g. Although this reduction in sample weight was small, over an extended period the weighing spring may deform and require replacement.

The battery used must be an Eveready No. 216 or a battery of equivalent voltage and weight. Batteries of a different weight would cause weighing errors, which would result in errors in moisture content.

Proper sample weight was obtained when the appropriate mark on the scale shaft (Figure 1)just became visible. Reading the sample weight could easily cause errors. The process of

holding the meter at eye level, pouring grain into the meter and stopping when mark first was visible caused errors. An error of up to 10 g was possible due to incorrect horizontal sighting or by having the mark more than just visible. A 10 g error in weight would result in a moisture content error of 1.5%. A better weighing system would result in improved accuracy.

Moisture Content: The moisture content chart printed on the body of the meter for wheat was capable of measuring moisture contents from 1.5 to 21.7%. This chart differs from the chart for Canadian hard red spring wheat included in the instruction manual, which indicates a capability of measuring moisture contents varying from 2.7 to 22.9%. There is no mention on the body of the meter to indicate the presence of charts for Canadian hard red spring wheat. Consequently, it is only natural to use the wheat charts on the meter body. This would result in moisture content errors. Canadian meters should have the appropriate chart on the meter body. All moisture content results in this report are based on the charts for Canadian hard red spring wheat in the instruction manual.

Charts provided indicated the meter was capable of measuring moisture contents from 3.6 to 20.8% in barley and 11.5 to 22.1% in oats. No moisture chart was supplied for rapeseed. The Qwik-Test was evaluated with samples ranging from 9.5 to 25.9% moisture content in wheat, 10.0 to 30.5% in barley, 11.1 to 27.8% in oats and 6.5 to 15.5% in rapeseed. 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 grain.

Figure 2 presents results for the Qwik-Test in wheat. It shows the deviation (error) of the meter readings from the true moisture content over a range of moisture contents. The best-fit line gives the average results of 20 samples of certified Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in laboratory) together with 19 samples of naturally tempered wheat from a field at Humboldt, Saskatchewan (originally dry windrows which had been rained upon) and 10 samples of several varieties of spring wheat from fields at Lethbridge, Alberta which were maturing in the windrow and had received no rain. Meter readings varied from 2.4 to 1.7% high over the range from 12 to 20% moisture content. Data showing statistical significance of the best-fit line are presented in Appendix II. Results could be improved by preparation of a new moisture chart for wheat. Subtracting 2.0% from all meter readings makes it accurate at 16% moisture content and in error by less than 0.5% over the entire range.

Figure 3 presents the best-fit line for the Qwik-Test in barley. It gives the average results for 12 samples of tempered Betzes barley and seven samples from four barley fields at Lethbridge, Alberta which were maturing in the windrow and had received no rain. Meter readings varied from 0.3% high to 0.4% low over the range of moisture content from 12 to 20%. Data showing statistical significance of the best-fit line are presented in Appendix II.

The best-fit line for the Qwik-Test in oats is given in Figure 4. This figure gives the average results for four samples of tempered Sioux oats and 11 samples of oats from three fields at Lethbridge, Alberta which had received no rain while maturing in the windrow. Meter readings varied from 0.4% high to 2.3% low over the range of moisture contents from 12 to 20%. Meter readings corresponded with true moisture content at 13.2%. The statistical significance of the best-fit line is given in Appendix II.

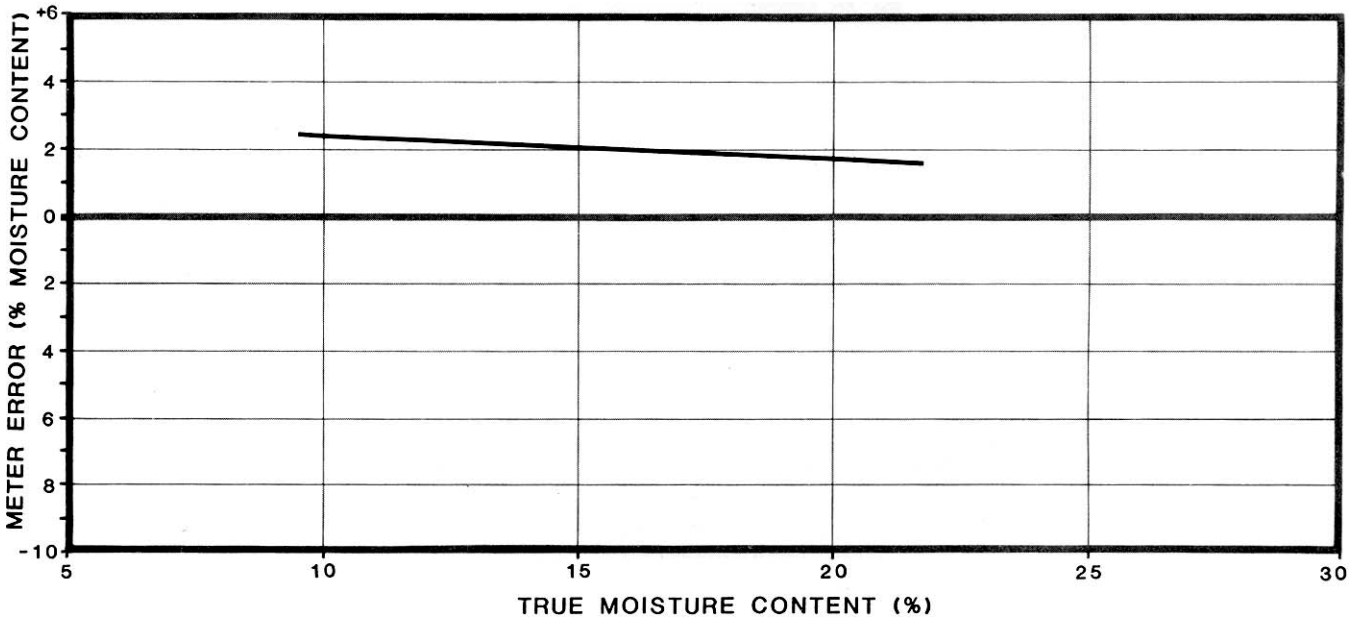

Figure 2. Deviations of Meter Readings for Qwik-Test in Wheat.

No moisture content charts were supplied for rapeseed. The meter, however, was capable of measuring moisture contents in rapeseed from 6 to 12.5% through the dial reading range of 0 to 25. To measure higher moisture contents a sample smaller than the 226.8 g would have to be used.

Figure 5 shows the best-fit calibration curve for rapeseed as obtained using six samples of several varieties of rapeseed which had received no rain while maturing in the windrow. The readings obtained all fell close to the best-fit line indicating reliable charts for rapeseed could be easily obtained. Data showing the statistical significance of the calibration curve are given

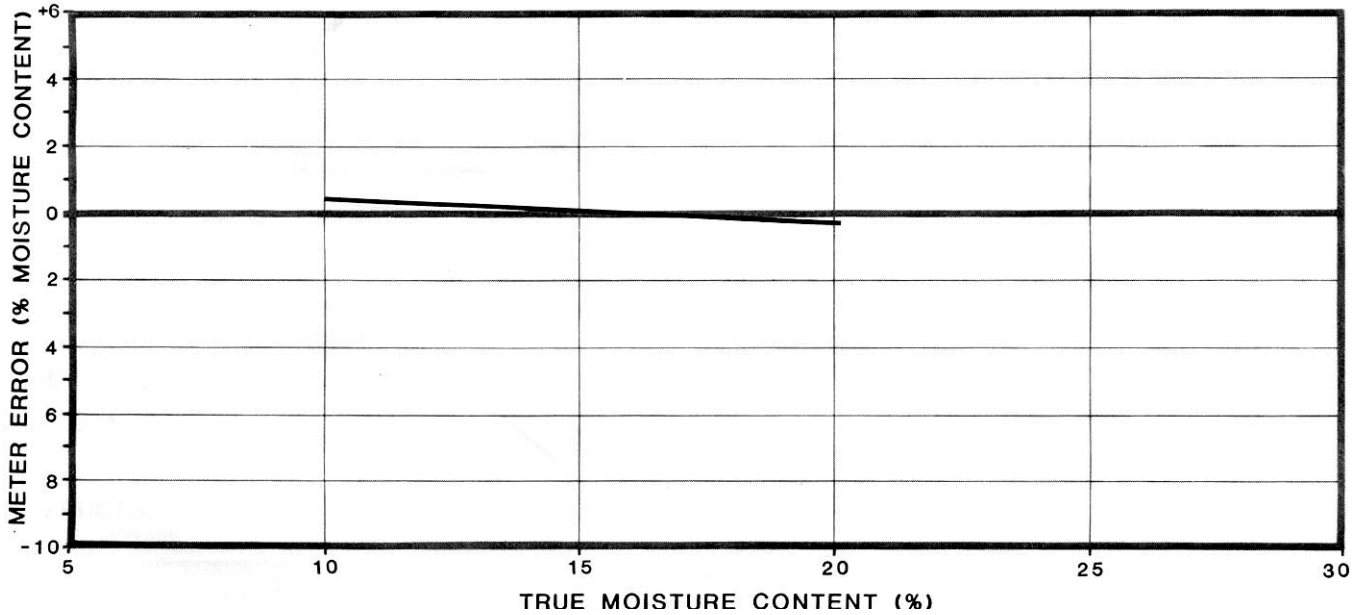

Figure 3. Deviations of Meter Readings for Quik-Test in Barley.

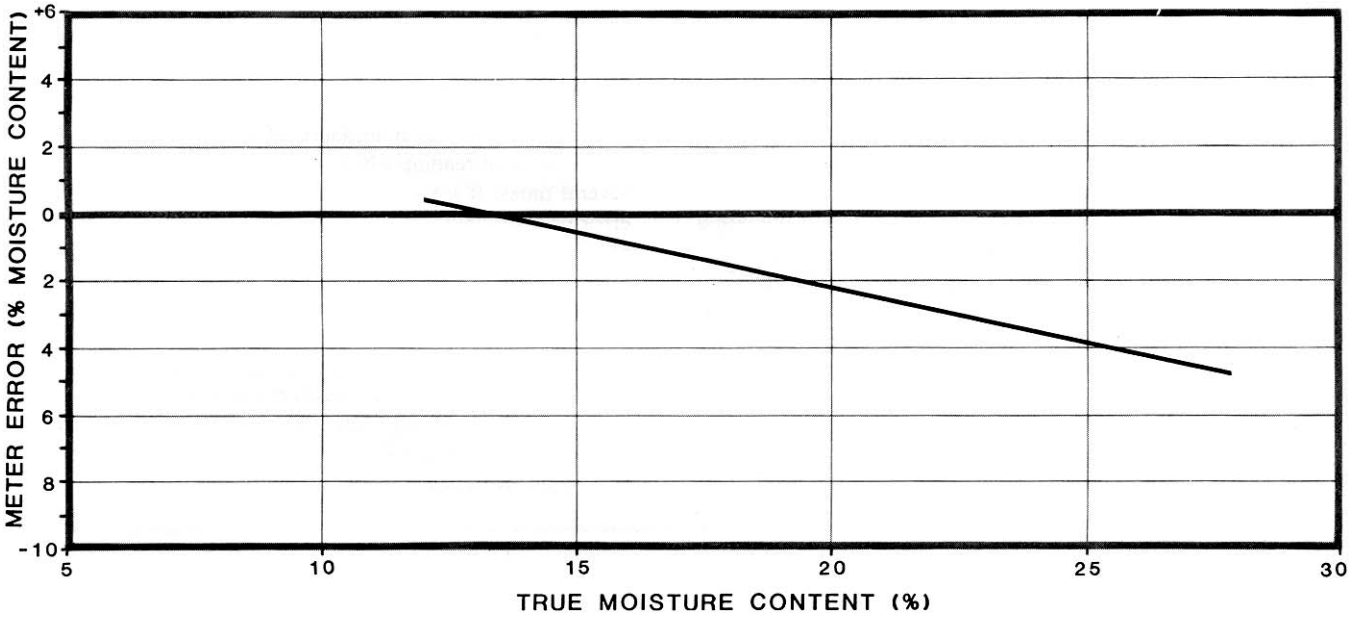

Figure 4. Deviations of Meter Readings for Qwik-Test in Oats.

in Appendix II. Moisture charts for rapeseed and other oilseed crops should be supplied with the meter.

Sources of Error: The following precautions must be taken to ensure accurate moisture content readings:

1. Loading instructions must be followed precisely. Improper filling or excessive shaking to level the grain resulted in higher packing density of the sample causing errors of 0.5 to 1% in moisture content.
2. The tester must be held by the lower part of the body. Meter readings could be 1 to 3 % high if the operator's hand was in contact with the top of the canister or on the scale knob.

Effect of Variables: The dielectric properties of grain with respect to moisture content can vary due to grain variety, kernel size, geographic location, maturity, weathering, artificial or natural drying, tempering (whether or not a dry windrow was rewetted with rain), and other factors depending on the year the grain was harvested. The manufacturer's charts and tables are an attempt to represent the average properties accurately for one sample of one variety. It is difficult to accurately predict the dielectric properties of all varieties of spring wheat grown in North America and to prepare an appropriate calibration chart.

To illustrate this point, Figure 2 shows fair results for the Qwik-Test in wheat. Figure 2 is the average best-fit line for three different types of spring wheat. Figure 6 represents best-fit lines for each of these types of wheat. The horizontal line is for samples from a field of Neepawa wheat at Humboldt in 1976. The windrows received rain during combining (naturally tempered) and samples were taken as the wheat dried in the field, very similar to what a farmer would do in the same situation. Meter readings varied from 1.8 to 1.9% high. One of

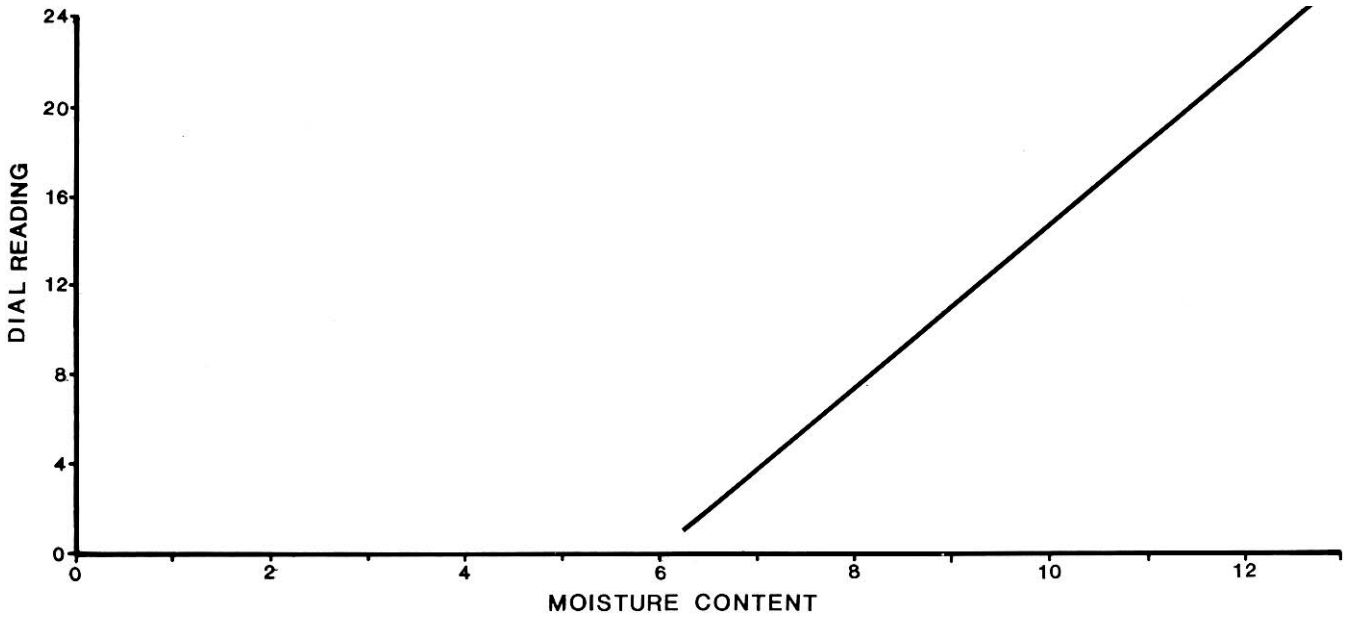

Figure 5. Calibration Curve for Qwik-Test in Rapeseed.

the sloping lines is for Neepawa wheat which was harvested at Lethbridge in 1975 and tempered artificially in the laboratory. Meter readings for this wheat varied from 3.0 to 1.3% high. The third line is for samples of several varieties of spring wheat at Lethbridge, Alberta in 1976. These samples received no rain while maturing in the windrow. In this case, meter results varied from 2.5 to 0.7% high. Data showing the statistical significance of these best-fit lines are presented in Appendix II.

It is nearly impossible for the manufacturer to prepare a calibration chart with correction factors to suit all possible combinations for one type of grain. The measurements involved would be difficult and time consuming and would defeat the purpose of a portable moisture meter. It is recommended that the owner annually check the results of his moisture meter against the moisture meter used by his local elevator agent. Comparing only a few samples should give enough information to determine how much to add to or subtract from the meter reading.

Only one Qwik-Test moisture tester was evaluated. This does not guarantee that results from all Qwik-Test moisture testers will be the same as presented in this report.

REPEATABILITY

Repeatability is a measure of how consistently a meter gives the same reading when the same sample of grain is tested several times. If a meter is designed so that chances of human error or instrument error are high, then the repeatability is poor. Conversely, if chances of human error and instrument error are low, repeatability is good. The coefficient of variation (defined in Appendix II) is a measure of repeatability. A low coefficient of variation indicates good meter repeatability while a high coefficient of variation indicates poor repeatability.

Table 1 gives the coefficients of variation for the Qwik-Test in wheat, barley and oats. These results show that the repeatability of the Qwik-Test was good in wheat and oats and very good in barley.

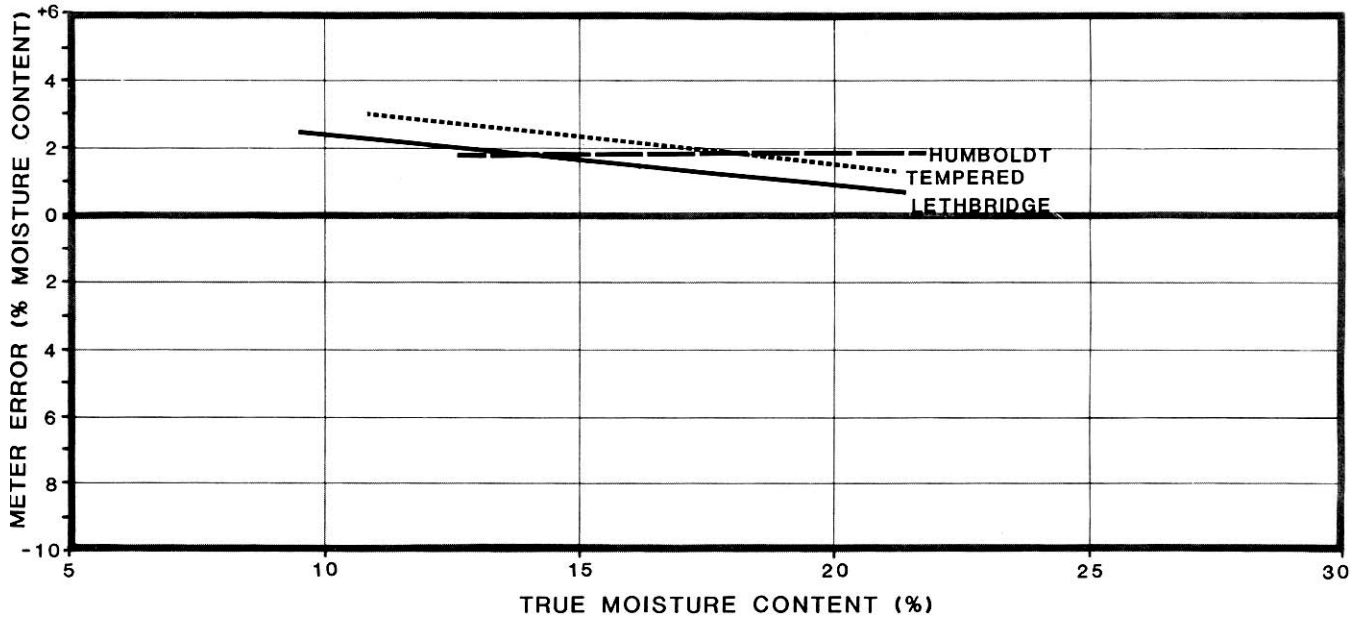

Figure 6. Deviations of Meter Readings for Qwik-Test in Three Different Types of Spring Wheat.

Table 1. Coefficients of Variation for the Qwik-Test

Wheat	Barley	Oats
1.28	1.03	1.90

The instruction manual recommends that the same sample should be tested three times and the dial readings averaged before a moisture percentage is determined. This procedure should be followed to avoid inaccurate readings of moisture contents due to differences in sample loading.

DURABILITY AND PORTABILITY

The Qwik-Test was well constructed and durable. It was small enough to be hand held while taking a moisture measurement, making it very adaptable for field use.

INSTRUCTION MANUAL

The instruction manual was easy to read and understand. In addition to information on operation and maintenance, it contained moisture charts for 25 grains.

Although the instruction manual indicated that the meter had to be separated to replace the battery, it did not clearly specify how to separate it. This clarification should be added to the instruction manual.

Charts, tables and weights used in the manual were only in English units of measurement, not consistent with the Canadian metric conversion program.

ACKNOWLEDGEMENTS

The assistance of the Canadian Grain Commission Research Laboratory, Winnipeg, in developing test procedures and laboratory techniques is gratefully acknowledged.

Appreciation and thanks is also extended to Lethbridge area farmers and the Agriculture Canada Research Station, Lethbridge for assistance in collecting grain samples.

APPENDIX I

SPECIFICATIONS

Model:	-- Qwik-Test
Serial Number:	-- 43904
Electrical Power Requirements:	– 9 V Eveready No. 216 Transistor Battery
Overall Heights:	-- 175 mm (6.9 in)
Diameter:	-- 106 mm (4.2 in)
Total Weight:	-- 500 g (1.1 lb)
Principle of Operation:	-- capacitance
Weight of Grain Sample:	-- 226.8 g (8 oz)

APPENDIX II

STATISTICAL INFORMATION

(a) Statistical Significance of 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. Sufficient information is presented to permit calculation of confidence belts.

In the following table, M = the reading of the Qwik-Test in percent moisture, wet basis, T = the moisture content of the sample in percent moisture, wet basis, as determined by the Canadian Grain Commission Research Laboratory oven method and R = the dial reading of the Qwik-Test, in scale graduations. Sample size refers to the number of grain samples used. Each meter sample represents the mean of five replicates (five meter readings) on that sample.

Grain Type	Fg. No.	Regression Equation	Simple Correlation Coefficient	Standard Error of Estimate	Residual Mean Square	Sample Size	Sample Mean
Wheat	2	M = 0.92T+3.32	0.97	0.76	0.58	49	16.34
Barley	3	M = 0.91T+1.38	0.97	0.71	0.57	19	14.85
Oats	4	M = 0.67T+4.34	0.95	0.90	0.81	15	15.11
Wheat, Humboldt	6	M = 1.01T+1.71	0.99	0.53	0.28	19	17.53
Wheat, Lethbridge	6	M = 0.85T+3.91	0.99	0.44	0.19	10	17.32
Wheat, Tempered	6	M = 0.83T+4.87	0.93	0.94	0.88	20	16.22
Rapeseed, Calibration	5	R = 3.68T - 22.16	0.98	1.60	2.57	6	12.07

(b) Meter Repeatability

Moisture meter repeatability (Table 1) was determined using the coefficient of variation. The coefficient of variation was determined by expressing the standard deviation as a percent of the mean for each of the five replicates taken on each sample. The values presented in Table 1 are the average coefficients of variation for all samples.

APPENDIX III

MACHINE RATINGS

The following scale is used in PAMI Evaluation Reports:

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

ALBERTA FARM MACHINERY RESEARCH CENTRE
3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080