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Evaluation Report 189

Dickey - john Model 707 Multi-grain Moisture Meter

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

DICKEY-john MODEL 707 MULTI-GRAIN MOISTURE METER

MANUFACTURER:
Dickey-john Corporation
P. O. Box 10
Auburn, Illinois 62615
U.S.A.

DISTRIBUTOR:
Dickey-john of Canada Ltd.
133A Milvan Drive
Weston, Ontario
M9L 1Z8

RETAIL PRICE:
$1250.00 (June, 1981, f.o.b. Chicago, Illinois).

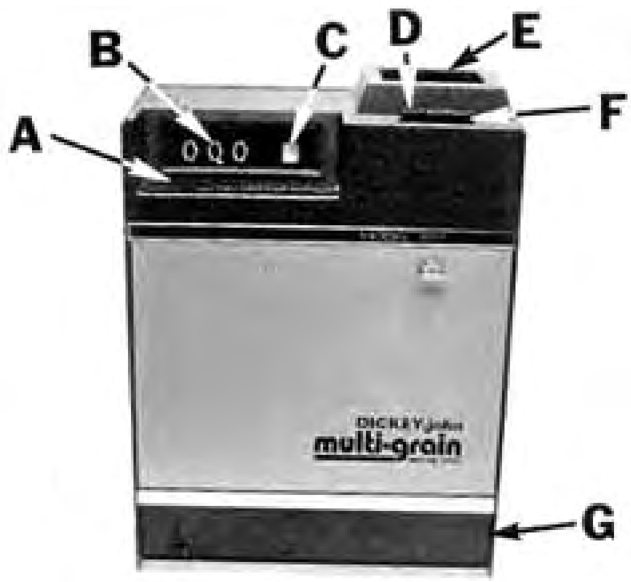

FIGURE 1. Dickey-john Model 707 Multi-Grain Moisture Meter: (A) Control Buttons, (B) Digital Readout, (C) Scale Balance Indicator, (D) Cell Load Button, (E) Scale Sample Loading, (F) Cell Dump Button, (G) Dump Tray.

SUMMARY AND CONCLUSIONS

Overall performance of the Dickey-john grain moisture meter was good in wheat, fair in barley and poor in oats and rapeseed. This compares to an overall performance of very good in wheat, barley and oats and excellent in rapeseed for the PAMI reference moisture meter, which is similar to meters commonly used in most prairie grain elevators.

Average meter error varied from 0.3% low in wheat, 0.8 to 1.4% high in barley, 0.6% low to 4.5% high in oats and from 1.1 to 5.3% high 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 fair in wheat and barley, poor in oats to good in rapeseed. Meter repeatability varied from excellent in wheat and rapeseed to very good in barley and oats.

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

The meter was easy to operate and a moisture measurement could be made in about 30 seconds. The meter was durable but the unit tested was not suitable for transporting for field use since a 110 V AC power supply was required. However, the same unit is available equipped with a 12 V DC rechargeable battery, which would make it transportable for field use, providing a flat surface for accurate sample weighing and meter use was available.

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 and calibration chart provided were clear and easy to understand.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Recalibrating the Dick-john Multi-Grain moisture meter to improve meter *accuracy in oats and rapeseed.*

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THE MANUFACTURER STATES THAT

The Model 707 Multi-Grain Moisture Meter is no longer being marketed under the Dickey-john name. Although it is still being manufactured by Dickey-john, it is now marketed as the Burrows Model 700 Digital Moisture Computer by the:

Seedburo Equipment Company
1022 West Jackson Boulevard
Chicago, Illinois 60607

The Seedburo Equipment Company has the laboratory capability to provide accurate charts for all grains.

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

GENERAL DESCRIPTION

The Dickey-john Model 707 Multi-Grain moisture meter determines moisture content using the capacitance principle. This principle is based on the change in dielectric properties of grain with changes in moisture content.

The meter is pushbutton operated and is programmable for a large variety of grains, including grains commonly grown on the prairies. Moisture contents are read directly from the digital readout. Temperature compensation is automatic.

The grain sample size of 250 g is weighed on an internally mounted spring scale.

The meter is self-contained in a sturdy plastic case complete with a lockable metal door, limiting access to calibration and adjustments to authorized personnel.

The tester operates on a 120 V AC power supply and is also available with an optional 12 V DC rechargeable battery.

Detailed specifications are found in APPENDIX I, while FIGURE 1 shows major components.

SCOPE OF TEST

The Dickey-john 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 performance. The Dickey-john 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 580 grain moisture measurements were made with the Dickey-john moisture' tester. All results in this report are expressed on a per cent wet-weight basis, consistent with common grain practice.

The Dickey-john 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 Dickey-john was easy to operate. The meter circuit was fully transistorized and no warm-up period was required. It was necessary to accurately weigh the

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

sample before determining its moisture content. Both the meter and spring scale required a level surface for best accuracy. Temperature compensation was automatic within the meter circuitry. In total, it took about 30 seconds to complete a moisture measurement.

The meter was easily calibrated by setting slope and intercept values for various pushbuttons, which controlled meter operation for different grain types. A calibration chart was provided which gave slope and intercept values for over 40 grains. Adhesive labels were supplied for pushbutton identification. A calibration check on slope and intercept values was required each time the meter was turned on and every few hours thereafter if the meter was used continuously.

The digital meter readout eliminated the errors of judgement that are inherent in some dial readouts. The digital readout displayed moisture content to the nearest 0.1% for all grain types.

Field Use: The unit evaluated was not easily transported for field use since it operated on 110 V AC power and was not equipped with a carrying case. It should be considered primarily for use indoors. However, the same unit was available equipped with a 12 V DC rechargeable battery and an optional carrying case. If equipped with these options and if a flat surface for accurate sample weighing and meter use was available, field use would be possible.

QUALITY OF WORK

Weighing Accuracy: The Dickey-john internal balance was easily adjustable to within 1.0 g of the 250 g sample size required for cereal grains and rapeseed. Grains requiring sample size other than 250 g had to be weighed on a separate grain scale. Careful weighing with the spring scale resulted in the required sample weight accuracy to obtain accurate moisture content measurements. However, pouring the sample until the balance tips, could result in errors in sample weight up to 5 g and a resulting 0.3% error in moisture content. Accurate sample weights are necessary to obtain accurate moisture content measurements.

Temperature Compensation: The Dickey-john was equipped with automatic temperature compensation. Temperature compensation required from 2 to 12 seconds before the moisture content could be read. 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 Dickey-john was capable of moisture measurement throughout these ranges.

The operator's manual indicated that the Dickey-john was capable of measuring moisture contents ranging from 0 to 45%.

The Dickey-john 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% in oats and 6.9 to 16.7% in rapeseed.

Accuracy: FIGURE 2 presents accuracy results for the Dickey-john 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 11 samples of Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in the laboratory), together with 15 samples of naturally tempered Neepawa wheat from Lethbridge (originally dry windrows which had been rained upon) and 11 samples of Neepawa wheat from Lethbridge which had received no rain while maturing in the windrow. Meter readings were 0.3% low over the entire range of moisture contents from 12 to 20%. At 14.5%, the upper limit for dry wheat, the PAMI reference meter read 0.5% high for the same samples.

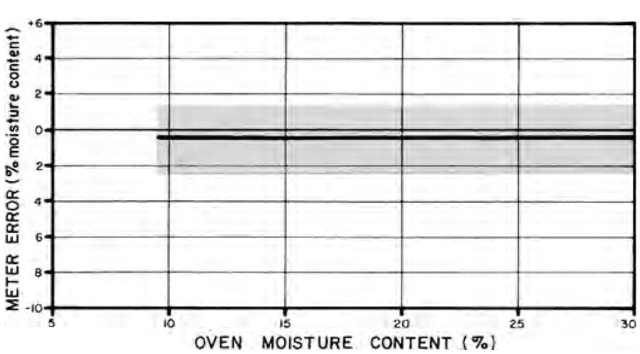

FIGURE 2. Accuracy of the Dickey-john in Wheat.

FIGURE 3 presents accuracy results for the Dickey-john in barley. The best-fit line gives the average results for 18 samples of tempered Betzes barley, 12 samples of naturally tempered Gait barley and 11 samples of Gait barley which had received no rain while maturing in the windrow. Meter readings varied from 0.8 to 1.4% high in the range of moisture contents from 12 to 20%, respectively. At 14.8%, the upper limit for dry barley, the Dickey-john read 1.0% high. This compares to a reading of 0.1% high for the PAMI reference meter at 14.8% in the same grain.

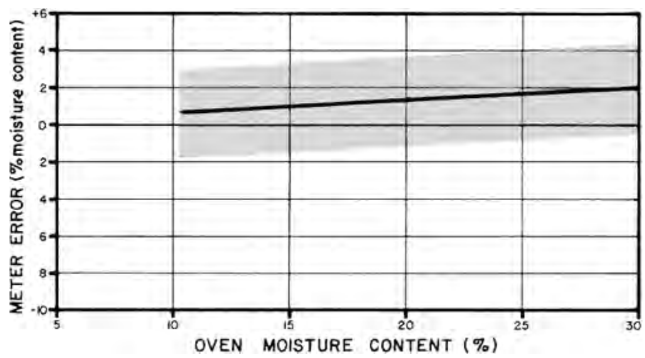

FIGURE 3. Accuracy of the Dickey-john in Barley.

Accuracy results for the Dickey-john in oats are given in FIGURE 4. The best-fit line gives the average results for 15 samples of artificially tempered Sioux oats and three samples of naturally tempered oats. Meter readings varied from 0.6% low to 4.5% high over the range of moisture contents from 12
Page 3 to 20%, respectively. At 14.0%, the upper limit for dry oats, the Dickey-john read 0.7% high while the PAMI reference moisture meter for the same grain samples read 0.1% low.

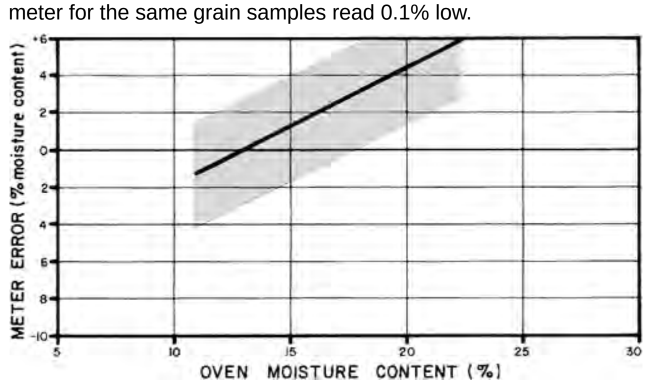

FIGURE 4. Accuracy of the Dickey-john in Oats.

The best-fit line for the Dickey-john in rapeseed is given in FIGURE 5. This figure gives the average results for 17 samples of artificially tempered Argentine rapeseed and three samples of naturally tempered rapeseed. Meter readings varied from 1.1 to 5.3% high over the range of moisture contents from 8 to 15%, respectively. At 10.5%, the upper limit for dry rapeseed, the Dickey-john read 2.6% high while the PAMI reference moisture meter for the same rapeseed samples was accurate.

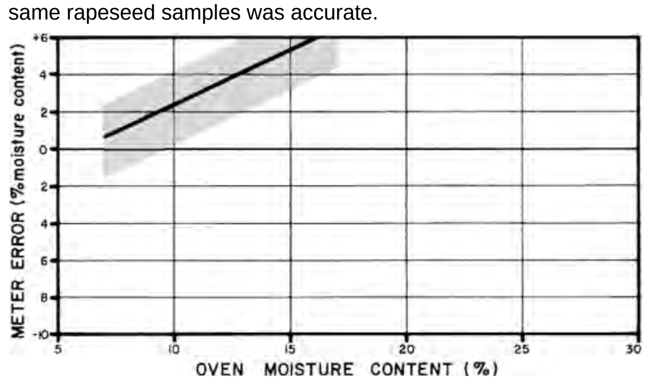

FIGURE 5. Accuracy of the Dickey-john in Rapeseed.

Uncertainty: The shaded belts on FIGURES 2 to 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, where as a narrow belt shows good meter certainty. Uncertainty of the Dickey-john was fair in wheat and barley, poor in oats and good in rapeseed. This compared to an uncertainty of very good in wheat, barley and oats and excellent in rapeseed for the PAMI reference meter.

Data showing further statistical interpretation are presented in APPENDIX II.

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 Dickey-john was excellent in wheat and rapeseed and very good in barley and oats. This compares to a repeatability of excellent in wheat and rapeseed and very good in barley and oats 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 charts 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, 9 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 to20%.

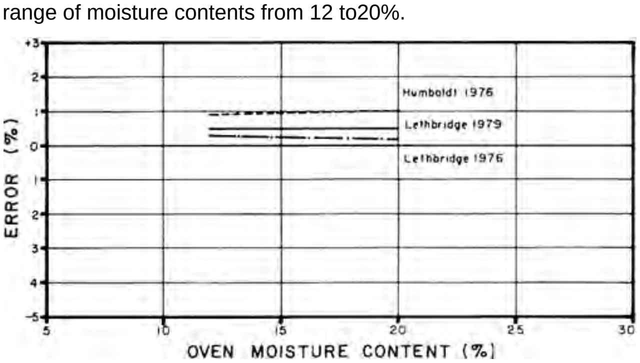

FIGURE 6. Deviations of Meter Readings for the PAMI Reference Moisture Meter in Three Different Groups of Wheat.

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 Dickey-john moisture meter 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.

OPERATOR'S MANUAL

The Dickey-john operator's manual included operating and maintenance instructions, and specifications. Supplied separately were charts giving slope and intercept values used for calibration of the Dickey-john for different grains. The manual was clear and concise and contained all the information necessary for moisture measurements.

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:	Dickey-john 707
Serial Number:	13396
Electrical Power Requirements:	120 V AC
Overall Height:	425 mm
Overall Width:	315 mm
Overall Length:	190 mm
Total Weight:	7.5 kg
Principle of Operation:	Capacitance
Sample Weight:	250g

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 Dickey-john in percent moisture, wet basis, while T = the moisture content of the sample in percent moisture, wet basis, as determined by the American Association of Cereal Chemists oven method. 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
DICKEY-john 707						
Wheat	2	M = 1.00T - 0.27	0.98	0.93	37	17.80
Barley	3	M = 1.07T - 0.04	0.98	1.15	41	18.67
Oats	4	M = 1.63T - 8.12	0.98	1.29	18	17.64
Rapeseed	5	M = 1.89T - 3.70	0.99	0.90	20	15.05
PAMI REFERENCE METER						
Wheat, Humboldt (1976)	6	M = 1.01T + 0.81	1.00	0.38	20	18.26
Wheat, Lethbridge (1979)	6	M = 1.01T + 0.42	0.38	0.38	34	17.32
Wheat, Lethbridge (1976)	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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