Evaluation Report No. E2379J
Printed: June, 1981
Tested at: Lethbridge
ISSN 0383-3445

Evaluation Report 188

John Deere Model TY9304 Grain Moisture Tester

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

JOHN DEERE TY9304 GRAIN MOISTURE TESTER

MANUFACTURER AND DISTRIBUTOR:

John Deere Ltd.
P.O. Box 1000
Grimsby, Ontario
L3M 4H5

RETAIL PRICE:

$315.49 (June, 1981, f.o.b. Lethbridge).

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Including temperature compensation procedures with the operating instructions printed on the meter case.

Chief Engineer: E. O. Nyborg

Senior Engineer: E. H. Wiens

Project Engineer: R. K. A/lam

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Consideration is being given to expanding the fourth operating statment to be: Compensate for temperature -wait 15 seconds and push button. Read corn directly. See instruction sheet for other grains.

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

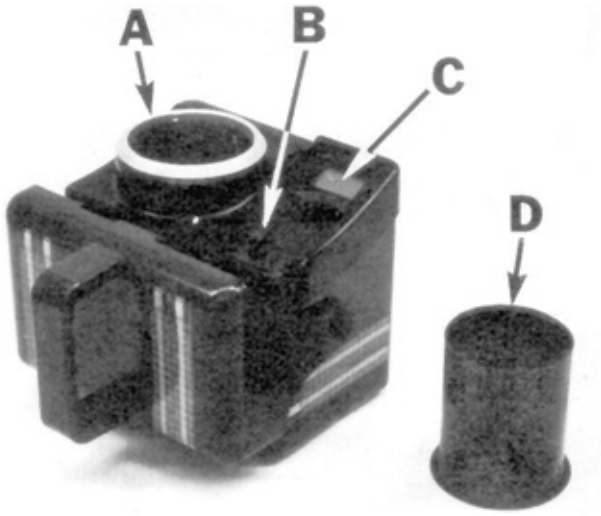

FIGURE 1. John Deere TY9304 Grain Moisture Tester: (A) Grain Cell, (B) Temperature Compensation Button, (C) Digital Readout, (D) Grain Cup.

SUMMARY AND CONCLUSIONS

Overall performance of the John Deere TY9304 moisture tester was *good* in wheat and oats, *poor* in barley and ex-*ce/lent* in 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 0.4% low in wheat, 0.3 to 2.5% high in barley, 0.3% low to 0.7% high in oats and 0.3% low in rapeseed over a range of moisture contents ranging from 12 to 20% for cereal grains and from 8 to 15% for rapeseed. Meter uncertainty varied from good in wheat, barley and oats to very good in rapeseed. Meter repeatability varied from fair in wheat, poor in barley, good in oats 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 John Deere 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 and easily tranported 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 instructions provided were clear and easy to understand.

GENERAL DESCRIPTION

The John Deere TY9304 moisture tester 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 grain cup provided is used to fill the grain cell until it reaches its full down position, which automatically turns on the meter. The meter's digital readout indicates the moisture content for corn directly. Conversion charts for common grains grown on the prairies are supplied on adhesive strips for pasting directly onto the meter body. A temperature compensated readout is available, after a 15 second delay, by pressing the temperature compensation button.

The tester operates on a 9 V transistor battery and is equipped with a carrying handle for field use.

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

SCOPE OF TEST

The John Deere 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 John Deere 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.

[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 moisture content of each grain sample was measured five times with the meter. In total, over 560 grain moisture measurements were made with the John Deere moisture tester. All results in this report are expressed on a per cent wet-weight basis, consistent with common grain practice.

The meter 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 John Deere was easy to operate. The meter was fully transistorized, requiring no warm-up period. Sample weighing was automatic. Sample size consisted of a cup full of grain required to fill the grain cell. Temperature compensated readings were obtained by pressing the temperature compensation button 15 seconds after sample loading and by applying the readout change to the moisture content obtained from the moisture charts. In total, it took about 30 seconds to complete a moisture measurement.

The digital meter readout eliminated errors of judgement inherent in some dial readouts. The meter readout displayed readings to the nearest 0.1 division, but moisture charts were given to the nearest 0.5 divisions. The chart divisions resulted in moisture contents in increments ranging from 0.1 to 1.2%, depending on the grain being tested.

The John Deere grain cell was spring loaded and the meter tuned on automatically when the grain cell reached the full down position. If grain was left in the grain cell, the meter readout would shut off auomatically after two minutes. This feature reduced premature battery failure. Meter calibration and the battery were tested by pressing the empty grain cell down and obtaining a meter readout of between 0.7 and 1.4.

The meter battery was replaced after approximately 360 meter readings. The replacement battery lasted throughout the remainder of the evaluation period. The battery was easily replaced and readily obtainable.

Field Use: The John Deere was provided with a carrying handle for convenient field use. A flat surface was required for meter use.

QUALITY OF WORK

Weighing Accuracy: A spring scale was built into the meter for automatic weighing. The meter was automatically turned on when the sample weight reached 192 g. Adjustment of the spring scale inside the meter was possible but not required during the evaluation.

Pouring rate affected the meter accuracy. Pouring too slowly resulted in scale bouncing and the moisture measurement being made with too small a sample. Pouring too quickly resulted in too large a sample before the meter could react. Errors in moisture content of up to 1.0% could result unless the cell was filled at a constant rate, over a 10 to 12 second period. This was clearly outlined in the operating instructions. Accurate sample weights are necessary to obtain accurate moisture content measurements.

Temperature Compensation: Temperature compensation with the John Deere was accomplished by pressing the temperature compensation button 15 seconds after filling the grain cell. When the button was depressed, the meter readout would change by the amount to be added or subtracted to the moisture content obtained from the chart for the grain being tested. 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 John Deere was capable of moisture measurement throughout these ranges.

Charts supplied with the John Deere indicated that it was capable of measuring moisture contents ranging from 7.3 to 25.0% in wheat, 8.6 to 24.1% in barley, 10.2 to 22.5% in oats and from 3.0 to 15.5% in rapeseed.

The John Deere 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 John Deere 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 12 samples of Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in the laboratory), together with 13 samples of naturally tempered Neepawa wheat from Lethbridge (orginally dry windrows which had been rained upon) and 10 samples of Nepawa wheat from Lethbridge which had received no rain while maturing in the windrow. Meter readings were 0.4% low in the 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.

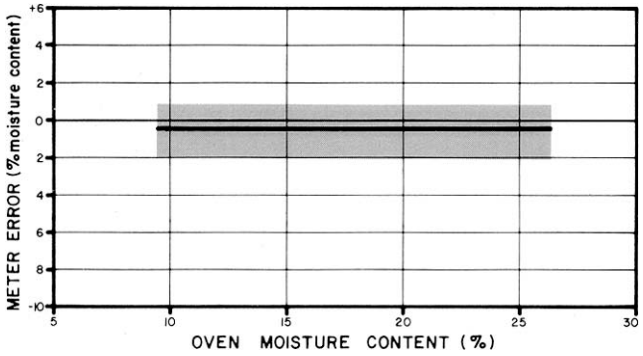

FIGURE 2. Accuracy of the John Deere in Wheat.

FIGURE 3 presents accuracy results for the John Deere in barley. The best-fit line gives the average results for 17 samples of tempered Betzes barley, 10 samples of naturally tempered Gait barley and six samples of Gait barley which had received no rain while maturing in the windrow. Meter readings varied from 0.3 to 2.5% high in the range of moisture contents from 12 to 20%, respecively. At 14.8%, the upper limit for dry barley, the John Deere read 1.1% high. This compares to a reading of 0.1% high for the PAMI reference meter at 14.5% in the same grain.

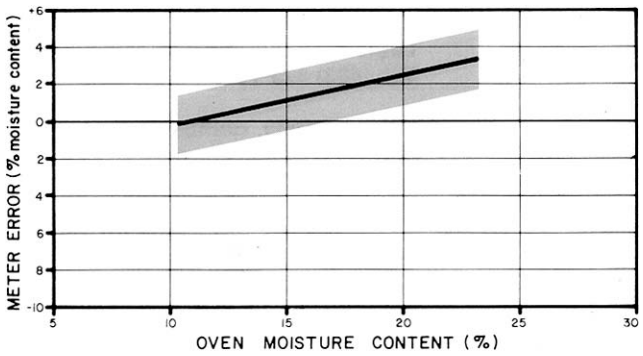

FIGURE 3. Accuracy of the John Deere in Barley.

Accuracy results for the John Deere in oats are given in FIGURE **4.** The best-fit line gives the average results for 15 samples of Sioux oats which were artificially tempered in the laboratory and three samples of naturally tempered oats. Meter readings varied from 0.3% low to 0.7% high over the range of moisture contents from 12 to 20%, respectively. At

14.0%, the upper limit for dry oats, the John Deere read 0.1% low while the PAMI reference moisture meter for the same grain samples also read 0.1% low.

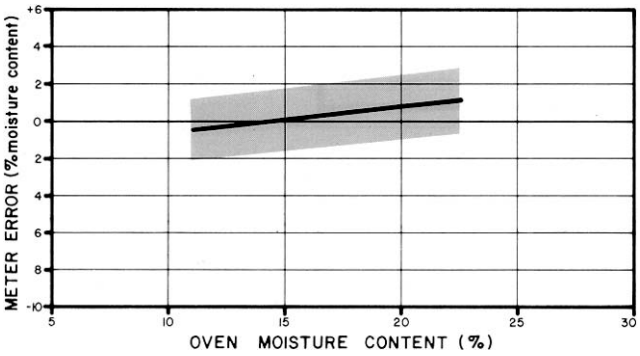

FIGURE 4. Accuracy of the John Deere in Oats.

The best-fit line for the John Deere in rapeseed is given in FIGURE 5. This figure gives the average results for 17 samples of Argentine rapeseed which were artificially tempered in the laboratory and four samples of naturally tempered rapeseed. Meter readings were 0.3% low in the range of moisture contents from 8 to 15%. At 10.5%, the upper limit for dry rapeseed, the John Deere meter read 0.3% low while the PAMI reference moisture meter for the same rapeseed samples was accurate.

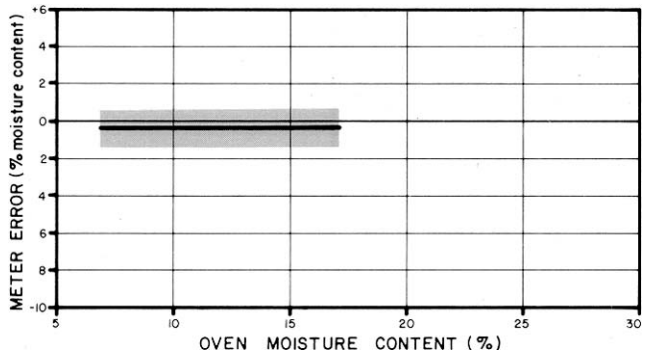

FIGURE 5. Accuracy of the John Deere in Rapeseed.

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, whereas a narrow belt shows good meter certainty. Uncertainty of the John Deere was good in wheat, barley and oats and very good in rapeseed. This compares to an uncertainty of very good in wheat, barley and oats and excellent in rapeseed for the PAMI reference moisture 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 John Deere was fair in wheat, poor in barley, good in oats and excellent in rapeseed. This compares to a repeatability of excellent in wheat and rapeseed and very good in oats and 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 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 varietites 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 to 20%.

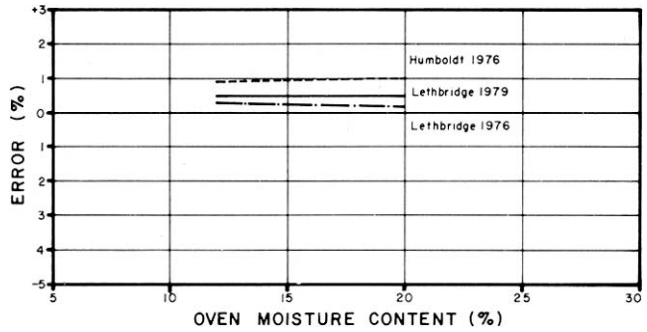

FIGURE 6. Deviations of Meter Readings for the PAMI Reference Moisture Meter in Three Different Groups of. Wheat.

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 John Deere 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

The John Deere moisture meter was durable and well suited for field use. No problems were encountered with meter operation throughout the evaluation.

OPERATOR'S MANUAL

The operator's manual included operating and service instructions. Operating instructions were also printed on the meter body for convenient field reference. Instructions printed on the meter body did not clearly outline the temperature compensation procedure. It is recommended that the temperature compensation procedure be included on the meter body.

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:	John Deere TY9304
Serial Number:	101076
Electrical Power Requirements:	1, 9 V transistor battery
Overall Height:	240 mm
Overall Width:	210 mm
Overall Length:	130 mm
Total Weight:	1.3 kg
Principle of Operation:	Capacitance
Sample Weight:	192 g

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 John Deere 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 represent the average of five meter readings on that sample.

Grain Type	Figure No.	Regression	Correlation Coefficient	Standard Error	Sample Size	Sample Mean
JOHN DEERE TY9304						
Wheat	2	M = 0.99T - 0.24	0.99	0.68	35	17.07
Barley	3	M = 1.27T - 2.94	0.99	0.70	33	17.11
Oats	4	M = 1.13T - 1.88	0.98	0.71	18	15.94
Rapeseed	5	M = 0.99T - 0.21	0.99	0.45	21	11.20
PAMI REFERENCE METER						
Wheat, Humboldt (1976)	8	M = 1.01T + 0.81	1.00	0.38	20	18.26
Wheat, Lethbridge (1979)	6	M = 1.01T + 0.42	1.00	0.38	34	17.32
Wheat, Lethbridge (1976)	6	M = 0.98T + 0.68	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)

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

This report is published under the authority of the minister of Agriculture for the Provinces of Alberta, Saskatchewan and Manitoba and may not be reproduced in whole or in part without the prior approval of the Alberta Farm Machinery Research Centre or The Prairie Agricultural Machinery Institute.