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# Evaluation Report 182


## On-Farm Model 900 Grain Moisture Tester

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

## ON-FARM MODEL GRAIN MOISTURE TESTER

**MANUFACTURER:**

On-Farm Products Division
T.C.I. Inc.
302 N. Walnut Street
Leroy, Illinois 61752
U.S.A.

**DISTRIBUTOR:**

Grandwest Enterprises Inc.
334 Packham Avenue
Sutherland Industrial Area
Saskatoon, Saskatchewan
S7N 2T1

**RETAIL PRICE:**

$239.00 (June, 1979, f.o.b. Lethbridge).

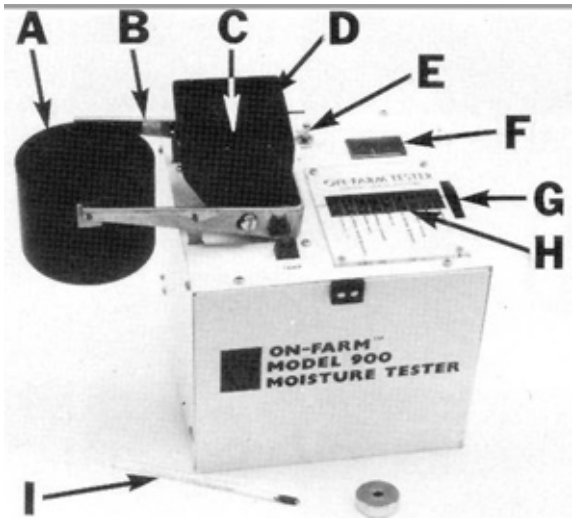


**FIGURE 1.** On-Farm Model 900 Grain Moisture Tester: (A) Grain Cup. (B) Balance, (C) Grain Test Cell, (D) Test Cell Dump Button (located behind funnel), (E) Power Switch, (F) Meter Indicator, (G) Dial Adjustment, (H) Dial Reading, (I) Thermometer.

## SUMMARY AND CONCLUSIONS

Overall performance of the On-Farm grain moisture tester was *good* in wheat, barley and oats and *very good* in rapeseed. This compares to an overall performance of *very good* in wheat, barley and oats 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% high to 0.5% low in wheat, 1.4 to 0.5% high in barley, 1.2 to 1.0% high in oats and from 0.4 to 0.6% 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 very good in wheat and oats, to excellent in barley and rapeseed. Meter repeatability varied from very good in wheat, barley and 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 On-Farm was capable of measuring moisture contents throughout these ranges.

The meter was easy to operate and a moisture measurement could be made in tess 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. Providing a spring loaded power switch to prevent premature battery failure resulting from leaving the meter on after use.
2. Improving the seal around the test cell dump door to prevent leakage of small kernel grains.
3. Supplying a metic (SI) thermometer and temperature correction chart to be consistent with the Canadian metric conversion program.

*Chief Engineer: E. O. Nyborg*

*Senior Engineer: E. H. Wiens*

*Project Engineer: R. K. Allam*

## THE MANUFACTURER STATES THAT

With regard to recommendation number:

### PAMI NOTE

No replies were received from the manufacturer to the above recommendations. The distributor was contacted and they were also not able to reach the manufacturer.

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

## GENERAL DESCRIPTION

The On-Farm model 900 moisture tester determines grain moisture content using the capacitance principle. This principle is based on the changes in dielectric properties of grain with changes in moisture content.

Moisture content of the sample is read directly from the meter dial for most crops commonly grown on the prairies. Moisture charts for additional grains are supplied in booklet form. Meter dial readings are corrected for temperature differences using the thermometer, calibrated in per cent moisture, stored in its own receptacle on top of the meter.

A grain sample of 142 g is weighed on an externally mounted grain cup and balance supplied with the meter.

The meter is supplied with a removable lid with carrying handle which also serves as a sample collection tray after moisture measurements are completed.

The On-Farm moisture tester operates on either a 115 V AC power supply or a 9 V transistor battery.

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

## SCOPE OF TEST

The On-Farm 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*.

Samples of several different varieties of each grain grown in several locations, were used to determine meter performance. The On-Farm was used with artificially tempered

*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.

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 560 measurements were made with the On-Farm. All results in this report are expressed on a per cent wet-weight basis, consistent with common grain practice.

The On-Farm 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 On-Farm was easy to operate. The meter circuit was fully transistorized and no warm-up period was required. 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 obtaining the sample temperature with the thermometer supplied. The thermometer was conveniently stored for transporting in its own receptacle on top of the meter. The thermometer was calibrated both in °F and in per cent moisture to be added or subtracted to the meter dial reading. In total, it took about one minute to complete the moisture measurement. To conform to the current Canadian conversion to the metric (SI) system, it is recommended that the thermometer and temperature correction charts be supplied in metric (SI) units.

The grain test cell of the On-Farm moisture tester was equipped with a push-button operated dump door which facilitated sample removal after the moisture content had been obtained.

The meter dial reading could easily be read to the nearest 0.1% for the grain types evaluated.

The On-Farm power button was not spring loaded and accidental battery failure could occur if the meter was left turned on after use. It is recommended that the manufacturer consider providing a spring loaded power switch to prevent accidental battery failure. The meter battery lasted throughout the evaluation period. The battery was easy to replace and was readily obtainable.

**Field Use:** The On-Farm was provided with a carrying lid with handle. The meter accessories all fit into the lid for convenient field transport. Moisture measurements could be made in the field, providing a flat surface, protected from wind, was available for sample weighing.

### QUALITY OF WORK

**Weighing Accuracy:** The On-Farm balance was equipped with an adjustable counterweight. The balance, as supplied, was accurate to within 0.8 g of the specified 142 g sample weight. Careful weighing with the balance resulted in the sample weight accuracy requiredto obtain accurate moisture content measurements. However, pouring grain into the tray until the balance tipped, resulted in samples being overweight by as much as 8 g and a resulting 0.7% 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 On-Farm was accomplished by using the thermometer supplied. The thermometer was calibrated both in °F and in percent moisture content to be added or subtracted to the meter dial reading. Both the thermometer and temperature compensation were 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 On-Farm was capable of moisture measurement throughout these ranges.

The scales on the On-Farm meter dial indicated that it was capable of measuring moisture contents ranging from 7 to 20% in wheat, 7 to 22% in barley, 9 to 24% in oats and 7 to 16% in rapeseed.

The On-Farm 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 On-Farm 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 10 samples of naturally tempered Neepawa wheat from Lethbridge (originally dry windrows which had been rained upon) and nine samples of Neepawa wheat which had received no rain while maturing in the windrow. Meter readings varied from 0.6% high to 0.5% low over the range of moisture contents from 12 to 20%. At 14.5%, the upper limit for dry wheat, the On-Farm read 0.3% high. This compares to a reading of 0.5% high for the PAMI reference meter at 14,5% in the same grain.

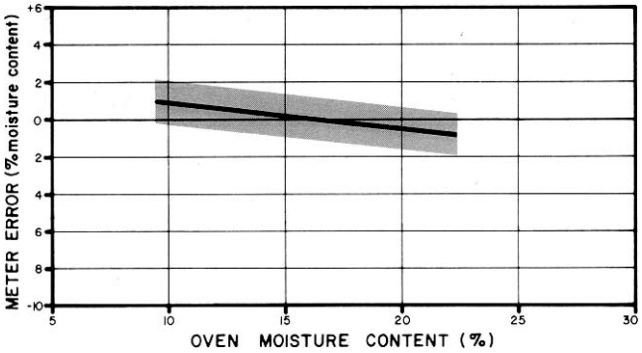


**FIGURE 2.** Accuracy of the On-Farm in Wheat.

FIGURE 3 presents accuracy results for the On-Farm in barley. The best-fit line gives the average results for 18 samples of tempered Betzes barley, 10 samples of naturally tempered Gait barley and seven samples of Gait barley which had received no rain while maturing in the windrow. Meter readings varied from 1.4 to 0.4% high in the range of moisture content from 12 to 20%, respectively. At 14.8%, the upper limit for dry barley, the On-Farm read 1.0% high. This compares to a reading of 0.1% high for the PAMI reference moisture meter at 14.8% in the same grain.

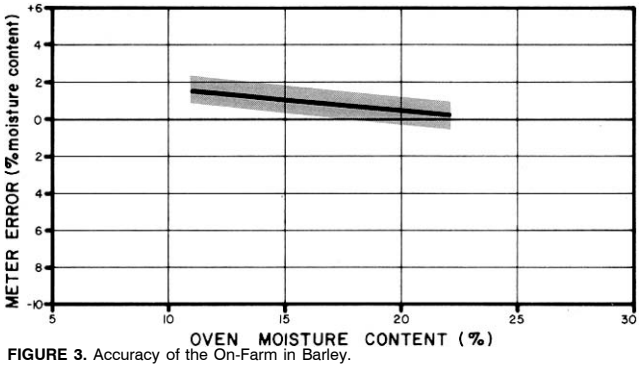


**FIGURE 3.** Accuracy of the On-Farm in Barley.

Accuracy results for the On-Farm in oats are given in FIGURE 4. The best fit line gives the average results for 16 samples of artificially tempered Sioux oats and three samples of naturally tempered oats. Meter readings varied from 1.2 to 1.0% high in the range of moisture contents from 12 to 20%, respectively. At 14.0%, the upper limit for dry oats, the On-Farm read 1.2% high while the PAMI reference moisture meter for the same grain samples read 0.1% low.

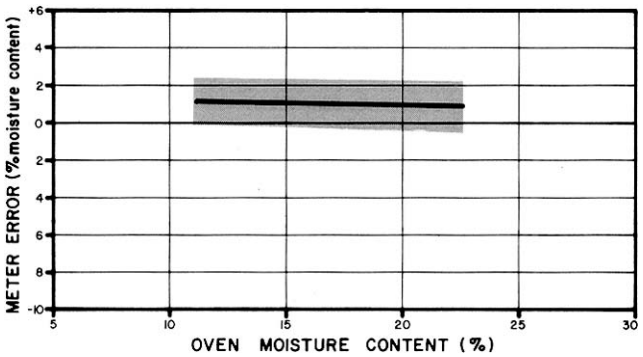

**FIGURE 4.** Accuracy of the On-Farm in Oats.

The best fit line for the On-Farm in rapeseed is given in FIGURE 5. This figure gives the average results for 16 samples of artificially temperedArgentine rapeseed and three samples of naturally tempered rapeseed. Meter readings varied from 0.4 to 0.6% high over the entire range of moisture contents from 8 to 15%, respectively. At 10.5%, the upper limit for dry rapeseed, the On-Farm read 0.5% high while the PAMI reference meter for the same rapeseed samples was accurate.

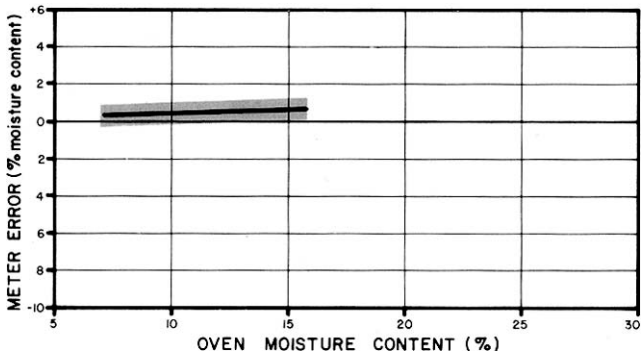

**FIGURE 5.** Accuracy of the On-Farm in Rapeseed.

**Calibration:** A letter from the manufacturer included with the meter instructed the operator to check On-Farm moisture tester readings with his local elevator to ensure correct calibration. The letter suggests that if On-Farm tester readings are more than 0.5% different from the elevator readings, the operator should recalibrate the meter by removing the back panel and turning the calibrate adjust screw. This would shift the meter calibration lines (FIGURES 2 to 5) either up or down depending on the direction turned. This procedure would shift meter calibration for all grain types and caution must be used if the meter reads high for one grain type and low for another type. Shifting the meter readings higher or lower could improve moisture readings in one grain type while reducing accuracy in another.

**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 On-Farm was very good in wheat and oats, and excellent in barley and rapeseed. This compares 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 On-Farm was very good in wheat, barley and 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 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 windrow. Meter results varied from 0.3 to 0.2% high over a range of moisture contents from 12 to 20%.

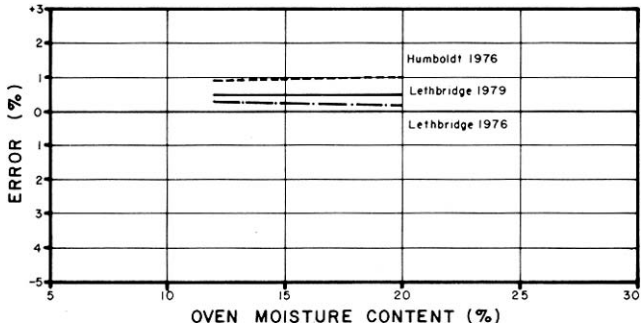

**FIGURE 6.** Deviations of Meter Readings for the PAMI Reference Moisture Meter in Three Different Groups of Wheat.

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 On-Farm 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.

**DURABILITY**

The On-Farm moisture meter was durable and well suited for field use. Small kernel grains such as rapeseed tended to leak out of the On-Farm grain test cell due to a loose fit between the lower door and the compartment walls. If undetected this could lead to inaccurate moisture readings resulting from incorrect grain sample sizes. It is recommended

that the manufacturer improve dump door installation to prevent small grain sample leakage.

**OPERATOR'S MANUAL**

The On-Farm operator's manual included information on meter operation, servicing and maintenance. Also included was a section on sampling procedure and a temperature correction chart. The manual was clear and concise and contained all the information necessary for moisture measurements.

Operation instructions were also printed on the side of the meter 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 No.:* | On-Farm 900-2 |
| *Serial Numer:* | 1903541 |
| *Electrical Power Requirements:* | 9V transistor battery or 120 V AC power supply |
| *Overall Height:* | 270 mm |
| *Overall Width:* | 220 mm |
| *Overall Length:* | 210 mm |
| *Total Weight* (complete): | 4.5 kg |
| *Principle of Operation:* | Capacitance |
| *Sample Weight:* | Low Moisture 142 g |
| | High Moisture 85 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 On-Farm in percent moisture, wet basis, white 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 sample, s used. Each meter sample represents the average of five meter readings on that sample.

| Grain Type | Figure No. | Regression | Correlation Coefficient | Standard Error | Sample Size | Sample Mean |
|---|---|---|---|---|---|---|
| ON FARM | | | | | | |
| Wheat | 2 | M = 0.86T + 2.28 | 0.99 | 0.53 | 31 | 16.23 |
| Barley | 3 | M = 0.88T + 2.80 | 1.00 | 0.29 | 35 | 17.91 |
| Oats | 4 | M = 0.97T + 1.57 | 0.99 | 0.57 | 19 | 16.72 |
| Rapeseed | 5 | M = 1.04T + 0.03 | 1.00 | 0.24 | 19 | 11.42 |
| 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 | 1.00 | 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 used in PAMI Evaluation Reports:

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