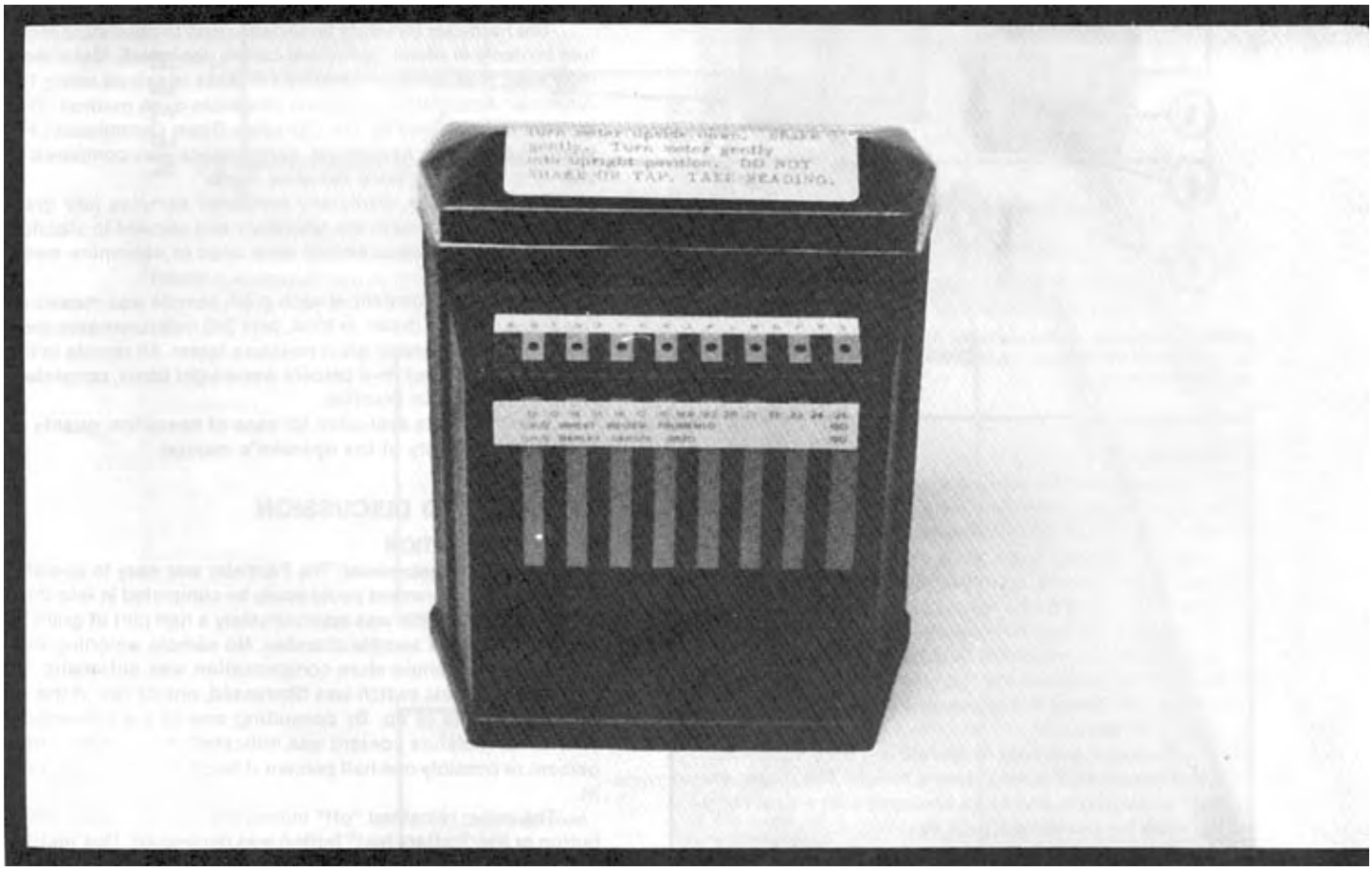
Printed: February 1986
Tested at: Lethbridge
ISSN 0383-3445
Group 7a

Evaluation Report 447



Farmeter Grain Moisture Tester

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

FARMETER GRAIN MOISTURE TESTER

MANUFACTURER AND DISTRIBUTOR:

Protimeter PIc.
Meter House
Fieldhouse Lane
Marlow, Buckinghamshire
SI7 1LX, England

RETAIL PRICE:

$200.00 (March, 1986, f.o.b. Lethbridge, Alberta).

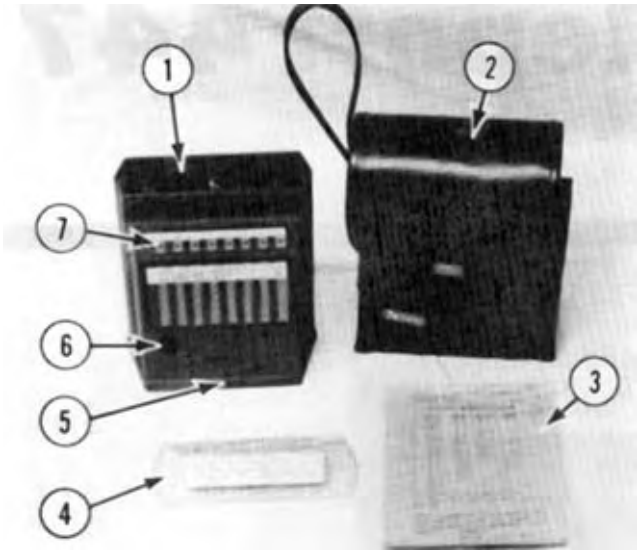


FIGURE 1. Farmeter Grain Moisture Tester: (1) Sample Chamber, (2) Carrying Case, (3) Conversion Charts, (4) Plastic Lid, (5) Calibration Check Switch, (6) Activating Button. (7) Indicating Lights.

SUMMARY

The accuracy of the Farmeter in wheat was good over a narrow range of moisture contents from about 10.5 to 15%. The overall performance was reduced due to less accurate readings from 15 to 20% and since readings above 20% were off the meter scale. In barley, meter accuracy was good over a range of moisture contents from 11.5 to 19%. At higher moisture contents, accuracy, uncertainty and repeatability deteriorated. The accuracy in canola was good over a range of moisture contents from 8 to 14.5%. Below and above this range, readings were off the meter scale.

The meter was easy to operate and a moisture measurement could be made in less a minute. The meter was light and portable and came equipped with a vinyl carrying case for convenient field use.

The operating instructions were easy to follow and were affixed to the back of the tester. Conversion charts for various grains were supplied on separate sheets.

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.

Manager/Senior Engineer: E. H. Wiens

Project Engineer: L. R. Coleman

GENERAL DESCRIPTION

The Farmeter grain moisture tester determines moisture content using the capacitance principle. The principle is based on the change in the dielectric properties of grain with changes in moisture content.

A moisture measurement is obtained by observing which of 16 lights light up and by referring to conversion charts. Conversion charts were provided for wheat, oats, maize and rape. Also, a sticker with a scale to read moisture content directly in wheat and barley was affixed to the front of the instrument.

Sample weighing is not required. Approximately a half pint of grain fills the sample chamber. Temperature compensation is automatic.

The meter, plastic lid and conversion charts are carried in a vinyl case. The test switches are spring loaded to avoid premature battery failure.

The meter operates on two 9-volt transistor batteries.

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

SCOPE OF TEST

The Farmeter moisture tester was used to determine moisture contents in wheat, barley and canola (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 a PAMI reference moisture meter[1].

For each grain, artificially tempered samples (dry grain which was moistened in the laboratory and allowed to stabilize before moisture measurement) were used to determine meter performance.

The moisture content of each grain sample was measured five times with the meter. In total, over 240 measurements were made with the Farmeter grain moisture tester. All results in the report are expressed on a percent 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 Farmeter was easy to operate. A moisture measurement could easily be completed in less than a minute. The sample was approximately a half pint of grain to completely fill the sample chamber. No sample weighing was necessary and temperature compensation was automatic.

When the test switch was depressed, one or two of the 16 indicating lights lit up. By consulting one of the conversion charts, the moisture content was indicated to the nearest one percent or possibly one-half percent if two adjacent lights were lit.

The meter remained "off" unless the spring loaded "test" button or the "battery test" button was depressed. This feature reduced risk of premature battery failure.

It was not necessary to replace the two 9-volt transistor batteries during the test. The batteries were readily obtainable and easily replaced.

Field Use: The Farmeter was equipped with a vinyl carrying case for convenient field use. A flat level surface was required.

QUALITY OF WORK

Sample Size: Sample weighing was not required. Approximately one half pint of grain was sufficient to fill the sample chamber.

Temperature Compensation: The automatic temperature compensation was not effective. For example, measuring the moisture content of a dry sample of wheat at 10° and 20°C resulted in an error in moisture content of 1%. At the same two temperatures in damp wheat, an error in moisture content of 2% resulted. Similar errors also resulted in canola. It is recommended for improved accuracy that the meter and grain sample both be the same temperature when making a moisture content measurement.

Measurement Range: The range of moisture content of greatest concern is between 12 and 20% for cereal grains and between 8 and 15% for canola (rapeseed). These ranges include dry, tough and damp stages.

The conversion chart supplied with the Farmeter moisture tester indicated it was capable of moisture content readings from 12 to 25% in wheat and barley, and from 6 to 15% in canola.

The Farmeter was evaluated with samples ranging from 9 to 25% in wheat, 11 to 25% in barley and 6.5 to 15% in canola.

Meter Performance (Accuracy, Uncertainty

[1]*The PAMI reference moisture meter used for this series of tests was a Motomco model 919, similar to the moisture meter used in most prairie grain elevators. Accuracy results for the reference moisture meter are presented in APPENDIX II.*

and Repeatability): To assess meter performance, three factors; accuracy, uncertainty and repeatability, should be considered. Accuracy indicates how close the average meter reading is to true moisture content. Uncertainty is a measure of scatter over the range of moisture contents measured, or how close the readings follow a “best-fit” line. The shaded belts (APPENDIX II) 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 a wide scatter and measurement uncertainty, whereas a narrow belt shows good meter certainty. 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.

The accuracy of the Farmeter in wheat was good in a narrow moisture content range from about 10.5 to 15%. At 14.5% moisture content, the upper limit for dry wheat, the average meter reading was 0.3% high. This compared to a 0.4% low reading for the PAMI reference moisture meter. From 15 to 20% moisture content, the meter was inaccurate. The meter readings below 10.5% and above 20% were off the meter scale and did not register. Throughout the meter range of 10.5 to 20% the uncertainty of the Farmeter in wheat was very good and the repeatability was fair to good.

Although no conversion chart was provided for barley, when using the scale provided on the sticker affixed to the front of the meter, the accuracy of the Farmeter in barley was good over a range of moisture contents between 11.5 and 19%. At 14.8% moisture content, the upper limit for dry barley, the average meter reading was 0.8% high. This compared to a reading of 0.5% low for the PAMI reference moisture meter. At moisture contents below 11.5% the Farmeter did not register a reading. Over the range of moisture contents from 11.5 to 19%, the uncertainty and repeatability of the Farmeter in barley were both very good. At readings above 19% moisture content, both uncertainty and repeatability deteriorated.

The accuracy of the Farmeter in canola (rapeseed) was good over a range of moisture contents from 8 to 14.5%. At 10.5% moisture content, the upper limit for dry canola, the average meter reading was 0.7% low while the PAMI reference moisture meter read 0.3% low. At readings below 8% and above 14.5% the readings did not register and were off the meter scale. Within the moisture content range of 8 to 14.5%, uncertainty in canola was very good. Repeatability was good from about 8 to 11%. Above this range, repeatability was unsatisfactory.

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 rewetted 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. 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 Farmeter grain moisture tester was durable and suited for field use. No problems were encountered throughout the evaluation. It was not necessary to replace the batteries.

OPERATOR’S MANUAL

Operating instructions were printed on the back of the meter and on the plastic cover. No operator’s manual was received with the instrument. The conversion charts for wheat, oats, maize and rape were included on a card, which fit inside the carrying case. A scale for wheat and barley was affixed to the front of the tester.

APPENDIX I
SPECIFICATIONS

MODEL:	Farmeter
SERIAL NUMBER:	600104
MANUFACTURER:	Protimeter Plc. Meter House Fieldhouse Lane Marlow, Buckinghamshire SL7 1LX England
ELECTRICAL POWER EQUIPMENT:	Two 9 V transistor batteries
OVERALL HEIGHT:	5.6 in (143 mm)
OVERALL WIDTH:	4.75 in (121 mm)
OVERALL LENGTH:	2.6 in (65 mm)
TOTAL WEIGHT:	14 oz (400 g)
PRINCIPLE OF OPERATION:	Capacitance
SAMPLE SIZE:	10 fl oz (285 mi)

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 5 below. 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 meter 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
FARMETER TESTER						
Wheat, 10.5 to 20% m.c.	2	M = 1.47T - 6.49	0.98	0.54	12	14.78
Barley, 11.5 to 19% m.c.	3	M = 1.14T - 1.27	0.98	0.47	10	15.28
Canola, 8 to 14.5% m.c.	4	M = 0.99T - 0.69	0.97	0.49	6	10.83
PAMI REFERENCE METER						
Wheat, 9 - 25% m.c.	5	M = 0.96T + 0.21	1.00	0.11	10	15.03
Barley, 11 - 25% m.c.	5	M = 1.00T - 0.57	1.00	0.26	14	15.78
Canola, 6 - 15% m.c.	5	M = 0.93T + 0.34	1.00	0.16	10	10.87

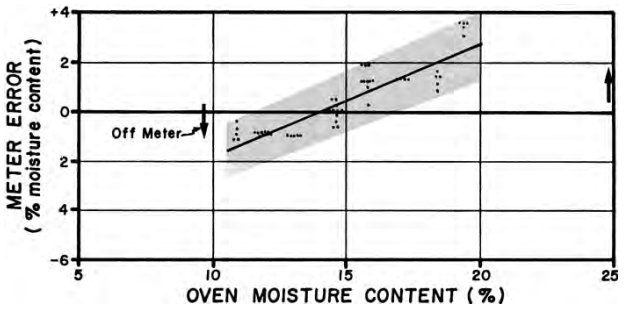


FIGURE 2. Accuracy of the Farmeter Moisture Tester in Wheat.

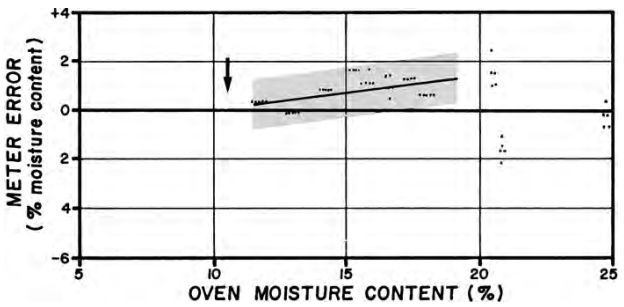


FIGURE 3. Accuracy of the Farmeter Moisture Tester in Barley.

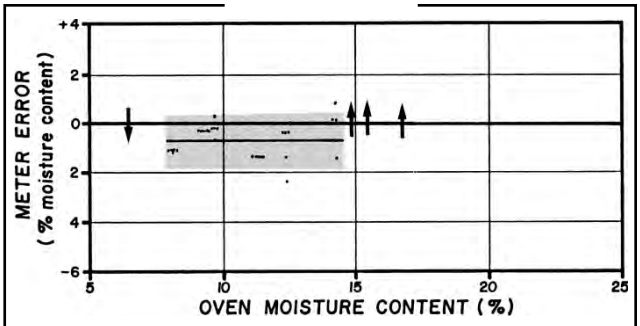


FIGURE 4. Accuracy of the Farmeter Moisture Tester in Canola (Rapeseed).

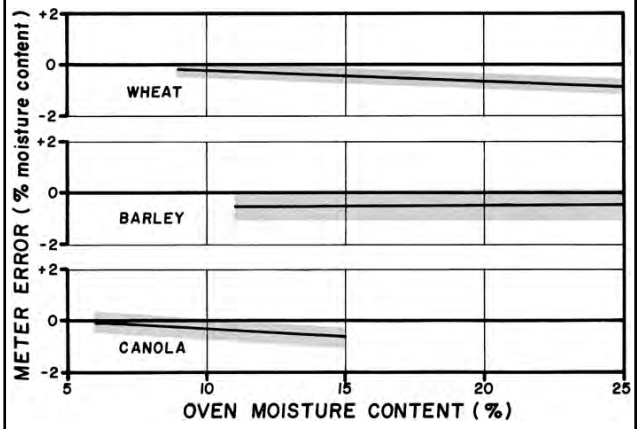


FIGURE 5. Accuracy of the PAMI Reference Moisture Meter in Wheat, Barley and Canola.

APPENDIX III
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Very Good
Good	Fair
Poor	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