Evaluation Report No. E0175J
Printed: April, 1977
Tested at: Lethbridge
ISSN 0383-3445

Evaluation Report 10

Labtronics 919 Grain Moisture Meter

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

Labtronics 919 Grain Moisture Meter

Manufacturer:
Labtronics 777
Grain Exchange Building
Winnipeg, Manitoba
R3B 0V3

Distributors:
--Alberta Wheat Pool
--Manitoba Wheat Pool
--United Grain Growers Ltd.
--Cargill Grain Co. Ltd.

Retail Price:
$540.00 (April, 1977, f.o.b. Winnipeg)

Figure 1. Detailed View of Labtronics 919 Grain Moisture Meter.

Summary and Conclusions

Accuracy of the Labtronics 919 grain moisture meter was very good in wheat and barley, fair in oats and excellent in rapeseed. Meter repeatability was excellent in all of the above grains.

Meter readings varied from 0.3 to 0.6% high in wheat, 0.4% high to 0.5% low in barley, 0.3% low to 1.7% high in oats and were accurate in rapeseeds, in the range of moisture contents from 12 to 20% for the cereals and 8 to 15% for rapeseed.

The high degree of meter accuracy and repeatability are attributed to the use of accurate sample weight, uniform sample loading, packing and distribution and the use of accurate sample temperature measurement and compensation charts. The only disadvantages with the Labtronics 919 were its relatively high cost and lack of portability.

The meter was simple to operate. A sample could be weighed and its moisture content obtained in about one minute.

Meter readings were dependent upon grain variety, geographic location in which the grain was grown and many other variables. It is recommended that a user occasionally check a few samples against the meter used at his local grain elevator as a check on meter calibration.

The meter was durable but was not suited for field use.

The instruction manual was clear and concise.

Recommendations

It is recommended that the manufacturer consider:

1. Modifying the dial to eliminate errors due parallax when obtaining a dial reading.
2. Supplying a metric thermometer and modifying the moisture charts using the appropriate SI units to be consistent with the Canadian metric conversion program.

Chief Engineer: E. O. Nyborg
Senior Engineer: E. H. Wiens
Project Engineer: D. A. Stafford

The Manufacturer States That

With regard to recommendation number:

1. The dial will be modified to eliminate errors due to parallax.
2. A Celsius thermometer and conversion charts using SI units are now available and will be supplied with all meters in the future.

Additional comments:

1. A new moisture content chart for oats is available and reflects the differences from true moisture content shown in the report.

General Description

The Labtronics 919 grain moisture meter is the standard meter used by the Canadian Grain Commission. It is also the meter used in most prairie grain elevators.

The Labtronics 919 determines moisture content using the capacitance principle. It measures the dielectric constant, which changes with the moisture content of grain.

The dial of the meter is marked from 0 to 100 in intervals of 0.5. Readings from the dial combined with the temperature of the grain sample are used to obtain moisture contents from charts supplied for all common grains grown on the prairies.

The Labtronics 919 may be purchased with either a 75 or 90 mm (3 or 3.5 inch) long cell (Figure 1). The meter evaluated was equipped with a 75 mm cell, which is adequate for determining moisture contents of all commonly grown grains on the prairies. Sample size depends on the grain and varies from 125 to 150 g for the 75 mm cell. The 90 mm cell is used for determining moisture contents of larger kernel products such as corn, peas and fababeans and uses a sample size from 175 to 250 g. The two cells are not interchangeable but a factory conversion from one cell size to another is possible.

The grain samples are weighed on an accurate triple beam balance supplied with the meter.

Also supplied are a thermometer (°F), pint measure to obtain bushel weight, rapeseed counter and a complete set of moisture charts.

The meter operates on a six volt, AC-DC adaptor or on four flashlight batteries. Complete specifications are found in Appendix I.

Scope of Test

The Labtronics 919 was used to determine moisture contents in wheat, oats, barley and 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 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 Labtronics 919.

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

Results and Discussion

EASE OF OPERATION

The Labtronics 919 was easy to operate. It was necessary to accurately weigh the sample before determining its moisture content. The meter circuit was transistorized and was “instant-on” so no warm-up period was required. About one minute was required to weigh a sample and make a moisture measurement. Both the meter and scale required a level surface for best accuracy. Temperature compensation was made by measuring the sample temperature (°F) and using the charts provided.

The meter was easily calibrated by turning the function calibrate knob to calibrate position, setting the dial reading to the red line and turning the adjust knob to obtain a minimum meter reading. Calibration was necessary when first turning the meter on or every couple of hours thereafter if the meter was used continuously.

The dial could be read to the nearest 0.5 division, which resulted in moisture contents to the nearest 0.1%. The error due to reading the meter from an angle (parallax) could easily be ±1.0, which would result in moisture measurements being in error by 0.2%.

The meter could easily be left turned on which could result in early battery failure. The batteries lasted the duration of the test, in which about 500 samples were tested. The batteries were easily replaced and were readily obtainable. The meter could also be operated from a 110 volt outlet using the six volt AC-DC adaptor.

ACCURACY

Sample Weight: The triple beam balance supplied with the meter was accurate and easy to use. Sample size was dependent on the grain and varied from 125 to 150 g when using the 75 mm long cell. Since the scale accurately weighed the samples, no errors in moisture content due to differences in sample weight were encountered. Accurate weighing required a level surface and a calm (i.e. no wind) environment. This detracted from use of the scale and meter in the field.

Moisture Content: Charts supplied with the Labtronics 919 indicated that it was capable of measuring moisture contents varying from 10.6 to 20.6% in wheat, 10.1 to 21.5% in barley, 10.5 to 19.6% in oats and 7.1 to 15.2% in rapeseed. The moisture charts were linear allowing them to be extrapolated beyond these ranges. The 919 was evaluated with samples ranging from 9.5 to 25.9% in wheat, 10.0 to 30.5% in barley, 11.1 to 27.8% in oats and 6.5 to15.5% 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 grains in the dry, tough and damp stages.

Figure 2 present results for the Labtronics 919 in wheat. It shows the deviation (error) of meter readings from true moisture content over a range of moisture contents. The best-fit line gives the average results for 24 samples of certified Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in the laboratory) together with 20 samples of naturally tempered Neepawa wheat from a field at Humboldt, Saskatchewan (originally dry windrows which had been rained upon) and 14 samples of several varieties of spring wheat from fields at Lethbridge, Alberta which had received no rain while maturing in the windrow. As can be seen, the difference between meter readings and true moisture content varied from 0.3% high at 12% moisture content to 0.6% high at 20%. Data showing statistical significance of the best-fit line are presented in Appendix II.

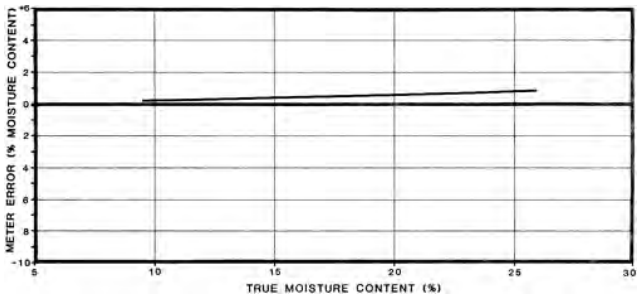

Figure 2. Deviations of Meter Readings for the Labtronics 919 in Wheat.

Figure 3 presents the best-fit line for the Labtronics 919 in barley. It gives the average results for six samples of tempered Betzes barley and 13 samples from four barley fields at Lethbridge, which received no rain while maturing in the windrow. Meter readings varied from 0.4% high at 12% moisture content to 0.5% low at 20% moisture content. Meter readings corresponded with true moisture content at 15.8%. Data showing statistical significance of the best-fit line are given in Appendix II.

The best-fit line for the Labtronics 919 in oats is given in Figure 4. This figure gives the average results for six samples of tempered Sioux oats and 12 samples of oats from fields at Lethbridge, which received no rain while maturing in the windrow. Meter readings varied from 0.3% low at 12% to 1.7% high at 20% moisture content. Meter readings corresponded with true moisture content at 13.1%. The statistical significance of the best-fit line is given in Appendix II.

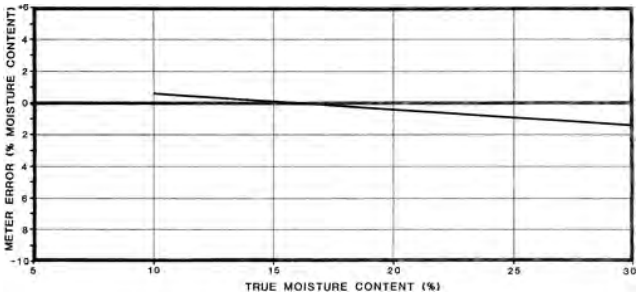

Figure 3. Deviations of Meter Readings for the Labtronics 919 in Barley.

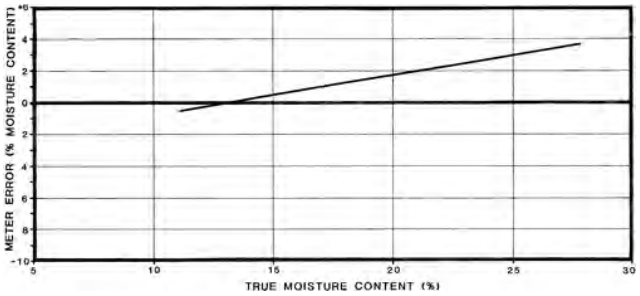

Figure 4. Deviations of Meter Readings for the Labtronics 919 in Oats.

The best-fit line for the Labtronics 919 in rapeseed is given in Figure 5. The line shows the average results for samples of several varieties from 10 fields, which had received no rain while maturing in the windrow. As can be seen, the Labtronics 919 was accurate over the entire range of moisture content from 8 to 15%. Statistical significance of the best-fit line is given in Appendix II.

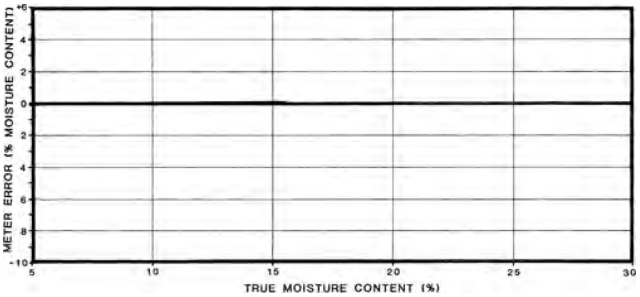

Figure 5. Deviations of Meter Readings for the Labtronics 919 in Rapeseed.

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

1. Accurate sample weight must be obtained when using the beam balance.
2. Accurate temperature measurements must be taken.
3. If meter and grain are at different temperatures, they should be brought to similar temperatures. If the temperatures are different the dial readings change as the two temperatures stabilize.

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, however, difficult to try to accurately predict the dielectric properties of all varieties of spring wheat grown in North America and to prepare an appropriate calibration chart.

This can be illustrated as follows. Figure 2 shows very good results for the 919 in wheat. Figure 2 is the average best-fit line for three different types of spring wheat. Figure 6 presents best-fit lines for each of these wheat types. The upper line is for samples from a field of Neepawa wheat at Humboldt, Saskatchewan 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 under the same situation. Meter readings varied from 0.9 to 1.1% high over the range of moisture contents tested. One of the lower lines is for Neepawa wheat, which was harvested a year earlier at Lethbridge, Alberta and which was artificially tempered in the laboratory. Meter readings for this wheat varied from 0.1% low to 0.7% high. The third best-fit line is for samples of several varieties of spring wheat from Lethbridge, Alberta in 1976. These samples had received no rain while maturing in the windrow. In this case, meter results varied from 0.4 to 0.2% high over the range. Data showing statistical significance of these best-fit lines are presented in Appendix II.

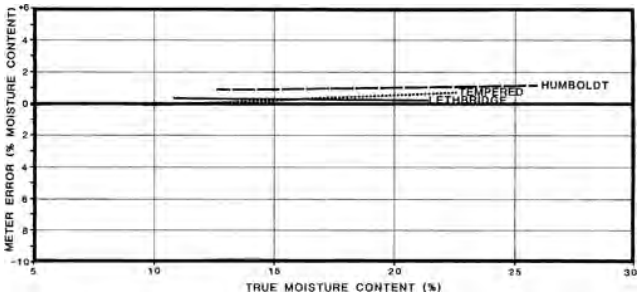

Figure 6. Deviations of Meter Readings for the Labtronics 919 in Three Different Types of Spring Wheat.

It can be seen from the above results that it is nearly impossible 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 difficult and time consuming and would really defeat the purpose of a portable grain moisture meter. It is recommended that the owner occasionally check a few samples against the meter used at his local grain elevator as a check on calibration. It should be noted that only one Labtronics 919 meter was evaluated. This does not guarantee that results from all

Labtronics 919 meters 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 low, repeatability will be good. Conversely, if chances of human error or instrument error are high, repeatability will be poor. The coefficient of variation (defined in Appendix II) is a measure of meter 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 Labtronics 919 in wheat, barley, oats and rapeseed. These results show that the repeatability of the Labtronics 919 was excellent in wheat, oats, rapeseed and barley.

The excellent repeatability of the 919 is attributed to the even loading, packing and distribution of the sample in the cell (Figure 1). This is accomplished by the dump cylinder and cone-shaped centre post in the cell.

Table 1. Coefficients of Variation for the Labtronics 919

Wheat	Barley	Oats	Rapeseed
0.73%	0.58%	0.59%	0.35%

DURABILITY AND PORTABILITY

The 919 was well constructed and encased in a durable aluminum diecast housing. It was not suitable for field use because no carrying case was provided to conveniently transport the meter, scale, thermometer, pint measure and moisture charts. Field measurements were also difficult since a flat surface, protected from the wind, was necessary for accurate sample weighing.

INSTRUCTION MANUAL

The instruction manual was clear and concise. It contained all the information necessary to make accurate moisture measurements. Although the various moisture and temperature compensation charts were expressed in terms of bushel weights and °F, conversion tables to convert to grams and °C were supplied in the manual. It is recommended that a thermometer in °C be supplied and that all moisture charts be expressed in the appropriate SI units, to be 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 are also extended to Lethbridge area farmers and the Agriculture Canada Research Station, Lethbridge for assistance in collecting grain samples.

APPENDIX I
SPECIFICATIONS

Model Number:	919
Serial Number:	13089
Electrical Power Requirements:	four, 1.5V flashlight batteries or a 6V, AC-DC adaptor for use from a 110V outlet
Overall Height:	178 mm (7.0 in)
Overall Depth:	241 mm (9.5 in)
Overall Width:	229 mm (9.0 in)
Total Weight (including scale):	7.8 kg (17.2 lb)
Principle of Operation:	capacitance
Weight of Grain Sample:	150 g (wheat, rapeseed) 125 g (barley, oats)

APPENDIX II
STATISTICAL INFORMATION

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

In the following table, M = the reading of the Labtronics 919 in percent moisture, wet basis, while T = the moisture content of the sample in percent moisture, wet basis, as determined by the Canadian Grain Commission Research Laboratory oven method. 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	Fig. No.	Regression Equation	Simple Correlation Coefficient	Standard Error of Estimate	Residual Mean Square	Sample Size	Sample Mean
Wheat	2	M=1.04T-0.20	0.99	0.53	0.28	58	15.95
Barley	3	M=0.90T+1.58	0.99	0.84	0.71	16	16.23
Oats	4	M=1.25T-3.27	0.93	1.96	3.82	18	16.46
Rapeseed	5	M=1.01T-0.06	0.98	0.56	0.32	10	11.19
Wheat Humboldt	6	M=1.01T+0.81	1.00	0.38	0.14	20	18.26
Wheat Lethbridge	6	M=0.98T+0.58	0.99	0.32	0.10	14	13.87
Wheat Tempered	6	M=1.06T-0.66	0.99	0.54	0.29	24	16.01

(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 variations for all samples.

APPENDIX III
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

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