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Evaluation Report 187

Labtronics 919 Grain Moisture Meter

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

LABTRONICS GRAIN MOISTURE METER

MANUFACTURER:

Labtronics Manufacturing
1050 Grain Exchange Building
157 Lombard Avenue
Winnipeg, Manitoba
R3B 0V3

DISTRIBUTOR:

-- Manitoba Wheat Pool
-- United Grain Growers Ltd.
-- Cargill Grain Co. Ltd.

RETAIL PRICE:

$750.00 (January, 1981, f.o.b. Winnipeg).

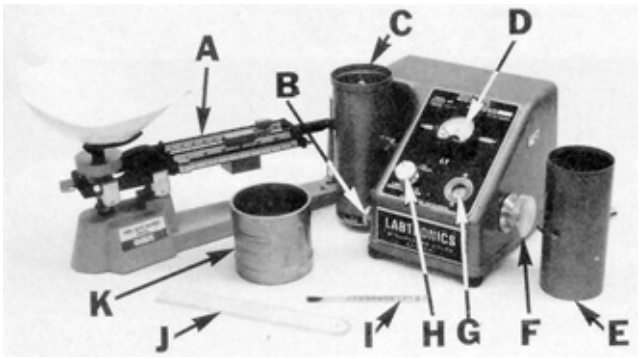

FIGURE 1. Labtronlcs 919 Grain Moisture Meter: (A) Triple Beam Balance, (B) Adjust Knob, (C) Cell, (D) Meter, (E) Dump Cylinder, (F) Dial Knob, (G) Dial Reading, (H) Function-Calibrate Knob, (I) Thermometer, (J) Rapeseed Counter, (K) Pint Measure.

SUMMARY AND CONCLUSIONS

Overall performance of the Labtronics 919 grain moisture meter was very good in wheat, barley and oats and excellent in rapeseed.

Average meter error varied from 0.5% high in wheat, 0.4% high to 0.5% low in barley, accurate to 0.3% low in oats and 0.1% low 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, barley and oats to excellent 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 Labtronics was capable of measuring moisture contents throughout these ranges.

The meter was easy to operate and a moisture measurement could be made in about one minute. The meter was durable but was not suitable for transporting 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 and moisture charts

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to the meter circuitry to obtain uniform meter response, regardless of the direction of knob rotation, while making moisture measurements and during meter calibration.

Chief Engineer: E. O. Nyborg

Senior Engineer: E. H. Wiens

Project Engineer: R. K. Allam

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. We will follow your recommendation.

MANUFACTURER'S ADDITIONAL COMMENTS

We have added the following items to our meter: magnifying cursor plate, indicator light, built-in thermometer holder and optional rechargeable nicad batteries and solar panel.

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

GENERAL DESCRIPTION

The Labtronics 919 grain moisture meter determines moisture content usihg the capacitance principle. This principle is based on the change in the dielectric properties of grain with changes in moisture content.

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

The Labtronics 919 may be purchased with either a 75 or 90 mm (3.0 or 3.5 in) diameter test cell. The meter evaluated was equipped with a 75 mm (3 in) test cell which is adequate for determining moisture contents of commonly grown grains on the prairies. Sample size depends on the grain type and varies from 125 to 150 g for the 75 mm (3 in) cell.

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

Also supplied are a thermometer (°C), rapeseed counter, pint measure, grain dump cylinder and a complete set of moisture charts.

The meter operates on an AC-DC adapter or a rechargeable 6 V battery pack.

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

SCOPE OF TEST

The Labtronics 919 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 is the method used by the Canadian Grain Commission Research Laboratory.

Samples of several different varieties of each grain grown in several locations, were used to determine performance. The Labtronics 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 550 measurements were made with the Labtronics 919. All results in this report are expressed on a per cent wet-weight basis, consistent with common grain practice.

The Labtronics was evaluated for ,ease of operation, quality of work and suitability of the operator's manual.

This Labtronics 919 is also being used as the PAMI reference moisture meter. It is used in conjunction with all moisture meters evaluated when moisture content measurements are being made. This permits moisture measurement comparisons of various moisture meters, independent of grain conditions in different years.

RESULTS AND DISCUSSION

EASE OF OPERATION

Moisture Measurement: The Labtronics 919 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. Both the meter and scale required a level surface for best accuracy. Temperature compensation was made by measuring sample temperature (°C) and using the charts provided. In

total, it took about one minute to complete a moisture measurement.

Moisture converaion charts indicated both the sample weight and grain test weight for each grain. Test weight ("bushel weight") was easily obtained by filling the pint measure, weighing its contents and converting to either pounds per bushel or kilograms per hectolitre from the charts provided.

The meter was easily calibrated by turning the function-calibrate knob to the calibrate position, setting the dial reading to "Cal' and turning the adjust knob to obtain a minimum (null) meter reading. Calibration was necessary when firat turning the meter on and about every hour thereafter if the meter was used continuously. The null meter reading was dependent on the direction in which the dial knob was turned when calibrating and on the direction on which the adjust knob was turned when obtaining meter readings. Differences in moisture content of 0.3% could result. It is recommended that the manufacturer modify meter circuitry to ensure similar meter readings, regardless of the direction in which the knobs are turned, both while calibrating and when making moisture measurements.

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 scale from an angle (parallax) could be as high as 1.0 division which could result in a 0.2% error in moisture measurements.

The meter could easily be left turned on after use which could result in premature battery failure. However, the batteries could be easily recharged by connecting the AC-DC adapter to a 110 V outlet.

Field Use: The Labtronics 919 was not provided with a carrying case. A flat surface, protected from the wind was required for accurate sample weighing. The Labtronics was not transportable for field use and should be considered primarily for use indoors.

QUALITY OF WORK

Weighing Accuracy: The triple beam balance supplied, was accurate to 0.1 g and was easy to use. Sample size was dependent on the grain type tested and varied from 125 to 150 g when using the 75 mm (3 in) cell. Careful weighing with the triple beam balance 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 1% error in moisture content. Accurate sample weights are necessary to obtain accurate moisture content measurements.

Temperature Compensation: Temperature compensation with the Labtronics was accomplished by obtaining the grain sample temperature with the thermometer provided and referring to temperature compensation charts. Both the thermometer and temperature compensation charts were found to be 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 Labtronics was capable of moisture measurement throughout these ranges.

Charts supplied with the Labtronics 919 indicated that it was capable of measuring moisture contents ranging from 7.7 to 25.9% in wheat, 10.4 to 26.5% in barley, 10.4 to 23.2% in oats and 6.8 to 14.8% in rapeseed.

The Labtronics 919 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 Labtronics 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 13 samples of Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in the laboratory), together with 12 samples of naturally tempered Neepawa wheat from Lethbridge (originally dry windrows which had been rained upon) and nine samples of Neepawa wheat from Lethbridge which had received no rain while maturing in the windrow. Meter readings were 0.5% high over the entire range of moisture contents from 12 to 20%.

FIGURE 3 presents accuracy results for the Labtronics in barley. The best-fit line gives the average results for 18 samples of tempered Betzes barley, seven samples of naturally tempered Gait barley and eight samples of Gait barley which had received no rain while maturing in the windrow. Meter readings varied from 0.4% high to 0.5% low in the range of moisture contents from 12 to 20%, respectively. At 14.8%, the upper limit for dry barley, the Labtronics read 0.1% high.

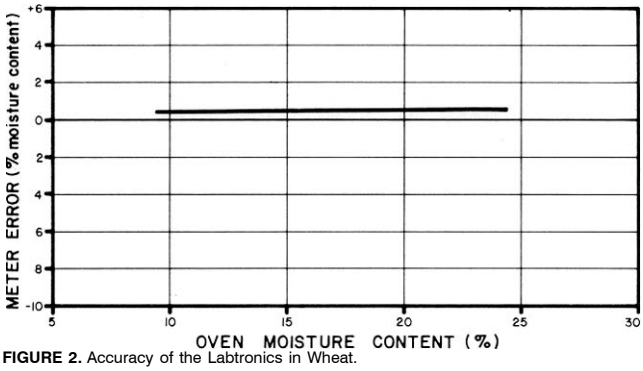

FIGURE 2. Accuracy of the Labtronics in Wheat.

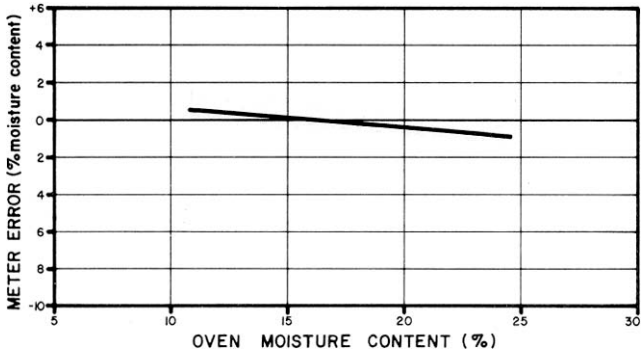

FIGURE 3. Accuracy of the Labtronics in Barley.

Accuracy results for the Labtronics 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 accurate to 0.3% low over the range of moisture contents from 12 to 20%, respectively. At 14.0%, the upper limit for dry oats, the Labtronics read 0.1% low.

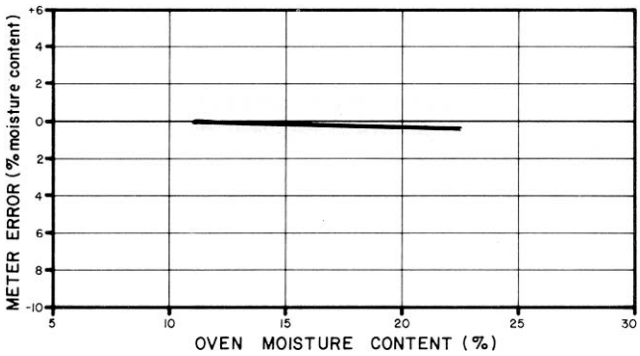

FIGURE 4. Accuracy of the Labtronics in Oats.

The best-fit line for the Labtronics in rapeseed is given in FIGURE 5. This figure gives the average results for 11 samples of artificially tempered Argentine rapeseed and four samples of naturally tempered rapeseed. Meter readings were 0.1% low over the entire range of moisture contents from 8 to 15%, respectively.

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 Labtronics was very good in wheat, barley and oats and excellent in rapeseed.

Data showing further statistical interpretation are presented in APPENDIX II.

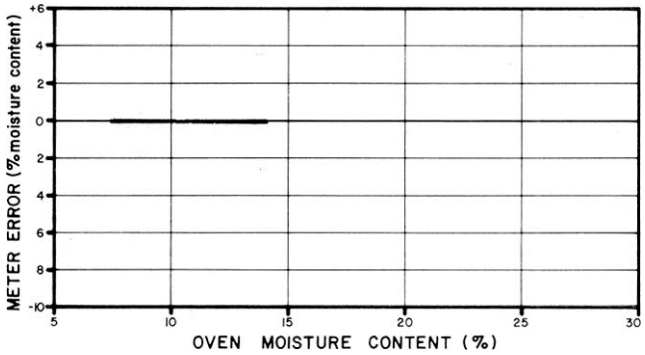

FIGURE 5. Accuracy of the Labtronics in Rapeseed.

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 Labtronics was excellent in wheat and rapeseed and very good in barley and oats.

Errors from Crop Variables: The dielectric properties of grain vary with grain variety, kemel 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 Labtronics 919 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%.

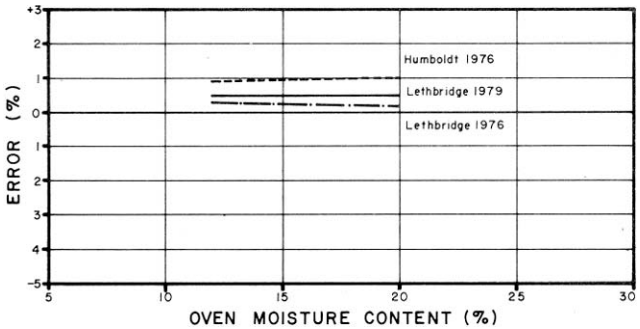

FIGURE 6. Deviations of Meter Readings for the Labtronics 919 Moisture Meter in Three Different Groups of Wheat.

It can be seen from the above results that though the Labtronics 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. 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 Labtronics 919 operator's manual included operating and service instructions, moisture charts for various grain types, a temperature conversion table and test bushel weight information for appropriate selection of wheat and badey moisture charts. The manual was clear and concise and contained all the information necessary for accurate 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:	Labtronics 919	
Serial Number:	78 1604	
Electrical Power Requirements:	110 V AC or rechargeable 6 V DC battery	
Overall Height:	210 mm with cell	
Overall Width:	280 mm with cell	
Overall Depth:	270 mm	
Total Weight (complete with beam balance):	7.9 kg	
Principle of Operation:	Capacitance	
Sample Weight:	Wheat	150 g
	Barley	125 g
	Oats	125 g
	Rapeseed	150 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 Labtronics 919 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	Figure No.	Regression	Correlation Coefficient	Standard Error	Sample Size	Sample Mean
Wheat	2	M = 1.01T + 0.42	1.00	0.38	34	17.32
Barley	3	M = 0.89T + 1.70	0.99	0.40	33	16.77
Oats	4	M = 0.96T + 0.47	0.99	0.53	19	15.48
Rapeseed	5	M = 0.99T + 0.01	1.00	0.20	15	10.27
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 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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