Evaluation Report No. E2379E
Printed: March,1981
Tested at: Lethbridge
ISSN 0383-3445

Evaluation Report 184

Froment NJF 1210 Moisture Tester

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI

PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

FROMENT NJF 1210 GRAIN MOISTURE TESTER

MANUFACTURER

N. J. Froment & Co. Ltd.
Cliffe Road, Easton, Stamford
Lincolnshire, PE9 3NP
England

DISTRIBUTOR

Norlen Systems Inc.
3450 Sidney Street
P.O. Box 758
Trenton, Ontario
K8V 5W6

RETAIL PRICE:

$359.00 (March, 1981, f.o.b. Lethbridge).

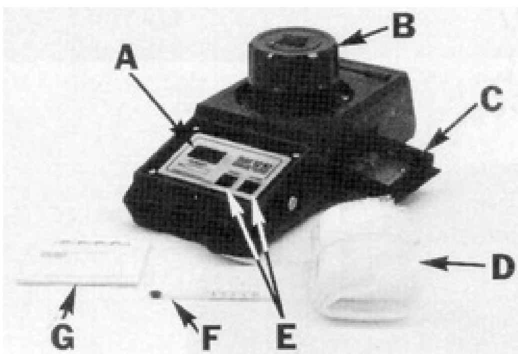

FIGURE 1. Froment NJF 1210 Moisture Tester: (A) Digital Readout, (B) Pressure Control Knob, (C) Grain Sample Tray, (D) Forage Sample Bags, (E) Control Buttons, (F) Thermometer, (G) Moisture Charts.

SUMMARY AND CONCLUSTIONS

Overall performance of the Froment NJF 1210 moisture tester *was fair* in wheat and rapeseed and *poor* in badey and oats. 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 praide grain elevators.

Average meter error varied from 0.8 to 1.2% low in wheat, 2.6 to 2.4% low in barley, 1.4 to 2.1% high in oats and from 2.1 to 0.7% 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, fair in barley and oats to very good in rapeseed. Meter repeatability varied from poor in wheat and badey, unsatisfactory in oats to fair 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 NJF 1210 was capable of measuring moisture contents throughout these ranges.

The meter was easy to operate and a moisture measurement could be made in less than one minute. The meter was durable and easily transported for field use. It was not necessary to weigh the grain sample before a moisture measurement could be made.

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. Instructions on both the meter body and 'in the instruction manual were clear and easy to understand.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to the meter to improve repeatability of meter readings.
2. Specifying the time after grain sample loading at which the sample moisture measurement should be taken.

Chief Engineer: E. O. Nyborg

Senior Engineer: E. H. Wiens

Project Engineer: R. K. Al/am

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Development has been completed on modifications to improve meter repeatability.
2. The operating instructions have been clarified to indicate that meter readings be taken immediately after sample loading.

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

GENERAL DESCRIPTION

The Froment NJF 1210 moisture tester determines moisture content using the resistance principle. This principle is based on the change in electrical resistance of grain with changes in moisture content.

The digital meter readout, combined with the temperature of the grain sample are used to obtain moisture contents from the conversion charts supplied for common grains grown on the prairies. The NJF 1210 may also be used for forage moisture determination[1] by using special polyethylene sample bags in place of the sample tray.

Sample weighing is not required. The sample tray is filled with a large handful of grain which is compressed with the pressure control knob. Predetermined compaction is obtained by turning the pressure control knob until a yellow band is fully visible above the knob face.

The tester operates on a 9 V transistor battery and is equipped with a carrying strap and component storage compartment.

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

SCOPE OF TEST

The Froment NJF 1210 was evaluated in wheat, badey, 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[2].

[1] For an evaluation of the Froment 1210 in forage, see PAMI Evaluation Report E0678A.

[2] 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.

Samples of several different varieties of each grain, grown in several locations, were used to determine performance. The NJF 1210 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 560 grain moisture measurements were made with the NJF 1210 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 Froment NJF 1210 was easy to operate. The meter was fully transistorized, requiring no warm-up period. No sample weighing was required. Sample size consisted of a large handful of grain required to fill the grain sample tray. Temperature compensation was made by measuring sample temperature and using the charts provided. In total, it took less than one minute to complete a moisture measurement.

The operator's handbook specified a time delay of 20 to 25 seconds after sample loading, before depressing the sample button and taking the meter reading for forage. No such a delay was specified for moisture measurements in grain. When testing tough and damp grain samples the readout would increase with time if the sample button was depressed at successive intervals after sample loading. Meter readings for this evaluation were taken immediately after sample loading. It is recommended that the manufacturer specify the time interval, if any, after which the sample button should be depressed after sample loading.

The digital meter readout eliminated the errors of judgement that are 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 0.4 to 1.4%, depending on the grain being tested.

The NJF 1210 sample control button was spring loaded and had to be manually depressed for moisture determination. This prevented accidental battery failure since it was impossible to leave the meter turned on. A battery test button was provided on the face of the meter for convenient battery power testing.

The meter battery was replaced after approximately 200 meter readings. The replacement battery lasted throughout the remainder of the evaluation period. The battery was easily replaced with the use of a screwdriver. Replacement batteries were readily obtainable.

Field Use: The NJF 1210 was provided with a carrying handle and a compartment to carry meter accessories for convenient field use.

QUALITY OF WORK

Sample Size: Sample weighing was not required. Sample size consisted of filling the sample tray level with the top. This required a large handful of grain. It was important to carefully fill the sample tray as specified in the operator's manual. Errors from underfilling or overfilling the tray could be as high as 1.0%.

Temperature Compensation: Temperature compensation with the NJF 1210 was accomplished by obtaining the grain sample temperature (°C) with the thermometer provided and referring to temperature compensation charts. Both the thermometer and temperature compensation charts 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 NJF 1210 was capable of moisture measurement throughout these ranges.

Charts supplied with NJF 1210 indicated that it was capable of measuring moisture contents ranging from 10.7 to 27.4% in wheat, 10.6 to 30.0% in badey, 10.0 to 29.8% in oats and from 5.5 to 21.0% in rapeseed.

The NJF 1210 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 NJF 1210 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 11 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 (originally dry windrows which had been rained upon) and 11 samples of Neepawa wheat from Lethbridge which had received no rain while maturing in the windrow. Meter readings varied from 0.8 to 1.2% low in the range of moisture contents from 12 to 20%. At 14.5%, the upper limit for dry wheat, the NJF 1210 read 0.9% low. This compares to a reading of 0.5% high for the PAMI reference meter at 14.5% in the same grain.

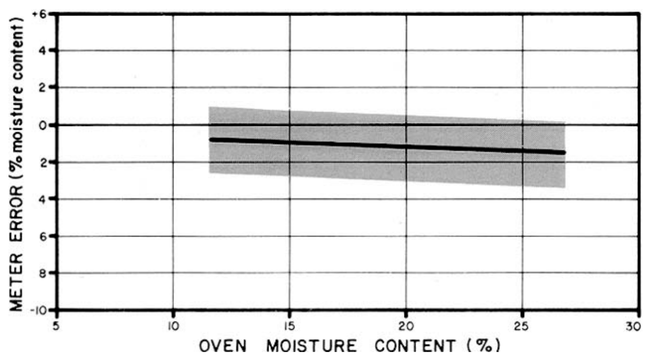

FIGURE 2. Accuracy of the NJF 1210 in Wheat.

FIGURE 3 presents accuracy results for the NJF 1210 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 2.6 to 2.4% low in the range of moisture contents from 12 to 20%, respectively. At 14.8%, the upper limit for dry barley, the NJF 1210 read 2.5% low. This compares to a reading of 0.1% high for the PAMI reference meter at 14.5% in the same grain.

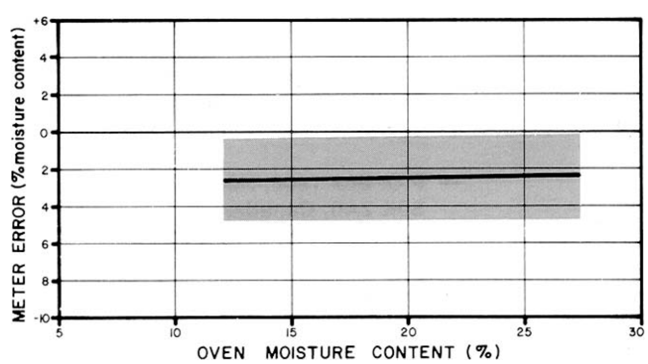

FIGURE 3. Accuracy of the NJF 1210 in Badey.

Accuracy results for the NJF 1210 in oats are given in FIGURE 4. The best-fit line gives the average results for 16 samples of Sioux oats which were artifically tempered in the laboratory and three samples of naturally tempered oats. Meter readings varied from 1.4 to 2.1% high over the range of moisture contents from 12 to 20% respectively. At 14.0%, the upper limit for dry oats, the NJF 1210 read 1.6% high while the PAMI reference moisture meter for the same grain samples read 0.1% low.

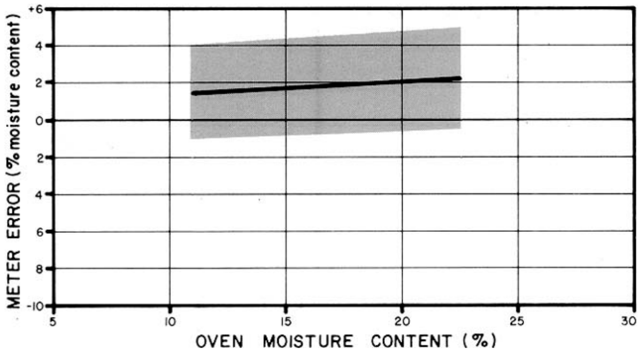

FIGURE 4. Accuracy of the NJF 1210 in Oats.

The best-fit line for the NJF 1210 in rapeseed is given in FIGURE 5. This figure gives the average results for 16 samples of Argentine rapeseed which were artificially tempered in the laboratory and three samples of naturally tempered rapeseed. Meter readings varied from 2.1 to 0.7% low in the range of moisture contents from 8 to 15%. At 10.5%, the upper limit for dry rapeseed, the NJF 1210 meter read 1.6% low while the PAMI reference moisture meter, with the same rapeseed samples, was accurate.

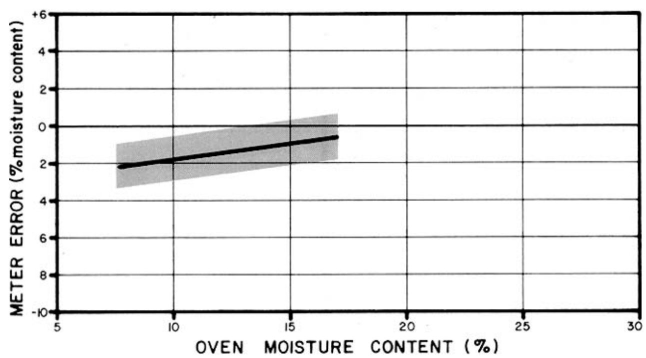

FIGURE 5. Accuracy of the NJF 1210 in Rapeseed.

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 NJF 1210 was good in wheat, fair in 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 NJF 1210 was poor in wheat and barley, unsatisfactory in oats, and fair 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 varieties of grain grown in the prairiesand 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 the windrow. Meter results varied from 0.3% to 0.2% high over a range of moisture contents from 12 to 20%.

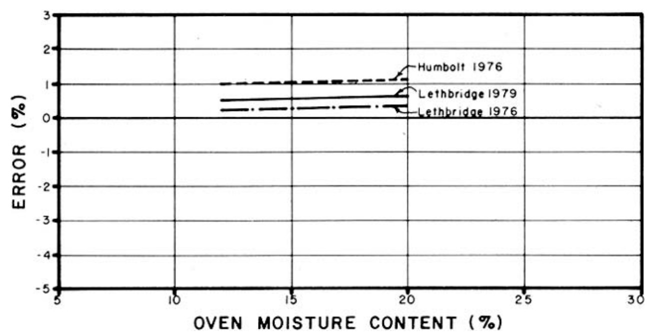

FIGURE 6. Deviations of Meter Readings for the PAMI Reference Moisture Meter in Three Different Groups of Wheat.

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 Froment 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 NJF 1210 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 maintenance instructions and a section on sampling technique. Operating instructions were also printed on the meter body for convenient field reference. The manual was clear and concise and contained all the information necessary for 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:	NJF 1210
Serial Number:	824 056
Electrical Power Requirements:	9 V transistor battery
Overall Height:	135 mm
Overall Width:	140 mm
Overall Length:	285 mm
Total Weight:	1.2 kg
Principle of Operation:	Resistance
Grain Sample Size:	Fill sample tray (large handful)

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 NJF 1210 in percent moisture, wet basis, while T = the moisture content of the sample in percent moisture, wet basis, as determined by the Amedcan 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
NJF 1210						
Wheat	2	M = 0.96T - 0.36	0.98	0.82	35	17.32
Barley	3	M = 1.03T - 2.97	0.97	1.00	31	16.46
Oats	4	M = 1.09T + 0.32	0.96	1.12	19	17.32
Rapeseed	5	M = 1.19T - 3.58	0.99	0.51	19	10.59
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 is 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)

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