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Evaluation Report 7

RDS Grain-O-Meter Moisture Meter

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

RDS Grain-O-Meter Moisture Tester

Manufacturer:
RDS (Agricultural) Ltd.
Boundary Court, Woodchester
Stroud, Gloucestershire, GL5 5PN, England

Distributor:
No longer distributed in Canada.

Figure 1. Detailed View of the RDS Grain-O-Meter.

Summary and Conclusions

The RDS Grain-O-Meter moisture tester was withdrawn from the Western Canadian market between the time the evaluation commenced and was completed. The manufacturer recognized that the meter was unsatisfactory for Western Canadian conditions due to the compressed dial scale in the critical moisture content range between 12 and 16%. A meter with an expanded dial scale in this moisture content range, for use in Western Canadian conditions, was to be supplied by the manufacturer. A modified meter was not received.

Accuracy of the RDS Grain-O-Meter was fair in wheat and poor in barley and oats. Meter repeatability was poor in wheat, fair in barley and unsatisfactory in oats. Meter readings varied from 0.7% high to 2.2% low in wheat, 0.1 to 3.6% low in barley, and 0.2% high to 3.1% low in oats over a range of moisture contents from 12 to 20%.

The RDS was not calibrated for rapeseed, however, a calibration curve was established during the test. The meter was simple to operate and a moisture content could be determined in less than 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 the user annually check a few samples against the meter used at his local grain elevator to determine a suitable correction factor.

The meter was durable and easily transported for field use. The instruction manual was poor.

Recommendations

It is recommended that the manufacturer consider:

1. Expanding the dial scales for cereal grains in the 12 to 16% moisture content range.
2. Replacing the grips with a device, which better controls sample size and grain compression.
3. Providing moisture charts or a dial scale for rapeseed and other oilseeds.
4. Supplying a thermometer to measure the sample temperature for temperature correction.
5. Providing a clear, concise instruction manual.

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The Manufacturer's Comments

The RDS Grain-O-Meter was designed for conditions in the United Kingdom, where grain is harvested in the 18 to 25% moisture range and then dried to 15 to 18% for storage. Tests conducted in the United Kingdom show that the meter is within ±1% over the range from 15 to 25% for local grains. The meter was imported to Canada at the request of several Canadian distributors.

Once RDS Ltd. discovered the shortcomings of the meter in Canadian conditions, the meter was removed from the Canadian market and all distributor stock was returned.

RDS Ltd. is presently developing a grain moisture meter suitable for Western Canada and Australia.

General Description

The RDS Grain-O-Meter moisture tester determines moisture content using electrical resistance. It measures the electrical resistance, which changes with the moisture content of grain.

There are two scales on the face of the meter. One scale is for measuring the moisture content of barley and oats from 12 to 23% in 0.5% increments. The second scale is for measuring the moisture content of wheat and maize from 13 to 25% in 0.5% increments. There were no charts for other grains.

Sample weighing was not required. Sample size is the quantity of grain needed to fill the jaws of the grips. Temperature compensation is required but no thermometer is supplied.

The meter operates on two 9 volt transistor batteries.

Complete specifications are found in Appendix I.

Scope of Test

The RDS was used to determine moisture contents in wheat, oats and barley and was calibrated for 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 RDS Grain-O-Meter.

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

Results and Discussion

EASE OF OPERATION

The RDS was simple to operate and a moisture measurement could be made in less than a minute. The meter could be hand held while making a moisture measurement making it very adaptable for field use. Temperature correction was made by subtracting or adding 0.5% moisture content from the dial reading for every 5.5°C (10°F) above or below 15.5°C (60°F). No thermometer was supplied for sample temperature measurement.

The dial scale was easily read to the nearest 0.5% moisture content in the range of 14 to 19% for barley and oats and 15 to 20% for wheat and maize. In the critical ranges below these moisture contents the dial scale was compressed and difficult to read. These lower ranges are extremely important because they represent the ranges where grain changes from dry to tough. For the meter to be suitable for Western Canada, the dial scale must be expanded at the lower end. Error due to reading the dial scale from an angle (parallax) was insignificant.

The meter was turned on by a spring loaded push button switch. This prevented premature battery failure since it was impossible to leave the meter turned on. The push button switch quit functioning twice during the evaluation due to an apparent poor contact within the sealed switch.

Only one set of batteries was used throughout the test in which over 500 samples were tested. The batteries were readily accessible, however, short battery leads made installation difficult.

The batteries were not readily obtainable.

ACCURACY

Sample Size: The size of the sample could vary greatly depending upon the quantity of grain in the jaws when the grip handles were squeezed. This large variation in sample size resulted in moisture content variations up to 3.25% due to the grain sample being subjected to different rates of compression. A different mechanism is required for better sample size control.

Moisture Content: The dial scales indicated that the meter was capable of measuring moisture contents from 13 to 25% in wheat and 12 to 23% in barley and oats. The RDS was evaluated with samples ranging in moisture content from 9.5 to 25.9% for wheat, 10.0 to 30.5% for barley, 11.1 to 27.8% for oats and 6.5 to 15.5% for 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 dry, tough and damp stages.

Figure 2 presents the results for the RDS in wheat. It shows the deviation (error) of the meter readings from true moisture content over a range of moisture contents. The best-fit line gives the average results for 13 samples of certified Neepawa wheat which had been artificially tempered (moisture added and samples stabilized in laboratory) together with 20 samples of naturally tempered wheat from a field at Humboldt, Saskatchewan (originally dry windrows which had been rained upon) and six samples of several varieties of spring wheat from fields at Lethbridge, Alberta which had received no rain while maturing in the windrow. Although the dial scale was calibrated only in the 13 to 25% range, the meter was capable of measuring a wider range if it were recalibrated for wheat. Meter readings varied from 0.7% high to 2.2% low over the range of moisture contents from 12 to 20%. Meter readings corresponded with true moisture content at 13.9%. Data showing statistical significance of the best-fit line are found in Appendix II.

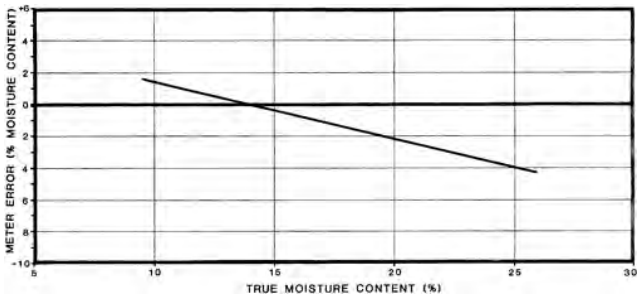

Figure 2. Deviations of Meter Readings for the RDS Grain-O-Meter in Wheat.

Figure 3 presents the best-fit line for the RDS in barley. It gives the average results for 13 samples of tempered Betzes barley and three samples from different barley fields at Lethbridge, which received no rain while maturing in the windrow. Although the dial scale was calibrated only from 12 to 23%, recalibration would permit a wider range of measurement. Meter readings varied from 0.1 to 3.6% low over a moisture content range of 12 to 20%. Meter readings corresponded with true moisture content at 11.8%. Statistical significance of the data are shown in Appendix II.

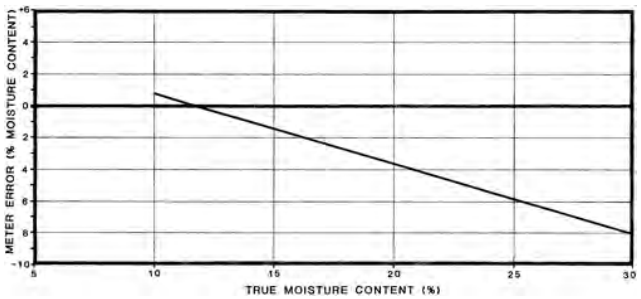

Figure 3. Deviations of Meter Readings for the RDS Grain-O-Meter in Barley.

The best-fit line for the RDS in oats is given in Figure 4. This figure gives the average result for six samples of tempered Sioux oats and 12 samples of oats from three fields at Lethbridge, Alberta, which received no rain while maturing in the windrow. Although the dial scale was calibrated from 12 to 23% a wider range of measurement was possible with recalibration. Meter readings varied from 0.2% high to 3.1% low over a moisture content range from 12 to 20%. Meter readings corresponded with true moisture content at 12.6%. The statistical significance of the best-fit line is shown in Appendix II.

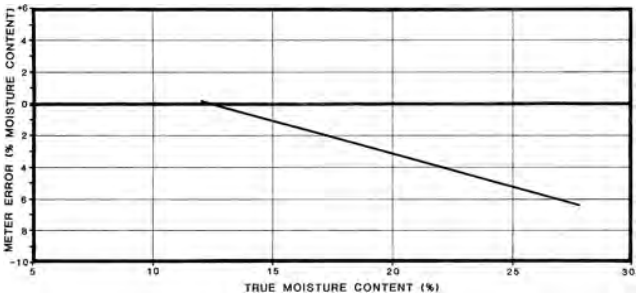

Figure 4. Deviations of Meter Readings for the RDS Grain-O-Meter in Oats.

No dial plate was supplied for rapeseed. The meter, however, was capable of measuring moisture contents in rapeseed from 6.5 to 15.5% using the dial scale for barley and oats over the range of dial readings from 12 to 18.

Figure 5 shows the best-fit calibration curve for rapeseed as obtained using eight samples of several varieties of rapeseed which had received no rain while maturing in the windrow. The readings fell close to the best-fit line indicating that reliable charts for rapeseed could be obtained. Data showing statistical significance of the calibration curve are given in Appendix II. Moisture charts or dial scales for rapeseed and other oilseed crops should be supplied with the meter.

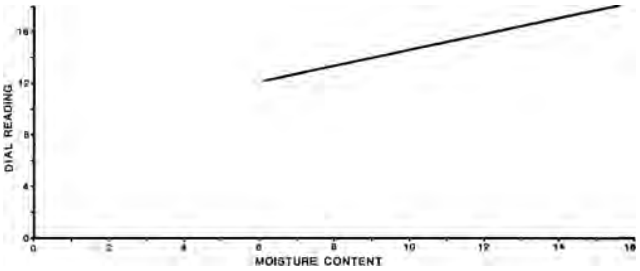

Figure 5. Calibration Curve for the RDS Grain-O-Meter in Rapeseed when using the Dial Plate for Oats and Barley.

Temperature Compensation: Poor repeatability and difficulty in controlling sample size made it difficult to check if the correction factor of 0.5% per 5.5°C (10°F), as indicated on the meter face, was correct for temperature compensation. No thermometer was supplied with the meter.

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

1. A constant sample size in the jaws of the grips was necessary to get good repeatability.
2. The moisture content of a sample was determined by moving the dial knob until one light went out and the other came on (Figure 1). The dial knob always had to be turned in the same direction or differences in moisture content readings would result due to hysteresis (a lag in the electrical response).

Effect of Variables: The electrical properties of grain with respect to moisture content can vary due to grain variety, kernel size, geographic location, maturing, weathering, artificial or natural drying, tempering (whether or not a dry windrow was rewetted with rain) and other factors depending upon 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 difficult to try to predict the electrical 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 one set of results for the RDS in wheat. Figure 2 is the average best-fit line for three different types of spring wheat. Figure 6 presents the 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 wheat dried in the field, very similar to what a farmer would do in the same situation. Meter readings varied from 0.6% high to 4.2% low over the range of moisture contents tested. One of the lower lines is for Neepawa wheat harvested a year earlier at Lethbridge, Alberta and which was artificially tempered in the laboratory. Meter readings for this wheat varied from 0.8% high to 3.4% low. The third best-fit line is for samples of several varieties of spring wheat from Lethbridge in 1976. These samples were maturing in the windrow and had received no rain. In this case, meter results varied from 2.0% high to 2.0% low over the range. Data showing statistical significance of these best-fit lines are presented in Appendix II.

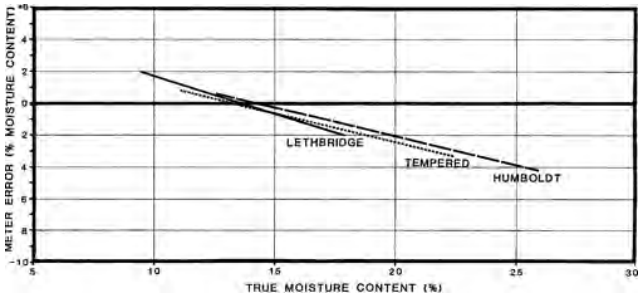

Figure 6. Deviations of Meter Readings for the RDS Grain-O-Meter in Three Different Types of Spring Wheat.

It can be seen from the above results that it is nearly impossible for the manufacturer to prepare a calibration chart with suitable correction factors to suit all the possible combinations for any one type of grain. The measurements involved would be time consuming and would really 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 grain elevator. Comparing only a few samples should give enough information to decide how much to add to or subtract from the meter reading.

It should also be noted that only one RDS Grain-O-Meter moisture tester was evaluated. This does not guarantee that the results from all RDS testers 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 high, the repeatability will be poor. Conversely, if chances of human error or instrument error are low, repeatability will be good. 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 RDS in wheat, barley and oats. These results show that the repeatability of the RDS was poor in wheat, fair in barley and unsatisfactory in oats. The lack of proper repeatability was largely due to difficulty in obtaining consistent sample sizes.

If repeatability of a meter is poor, several moisture content readings of the same sample should be averaged to ensure that the proper moisture content is obtained.

Table 1. Coefficients of Variation for the RDS

Wheat	Barley	Oats
2.98%	0.823%	3.16%

DURABILITY AND PORTABILITY

The RDS was well constructed and durable. It was encased in a metal box complete with carrying handle. It could be hand held while making moisture measurements, making it very adaptable for use in the field.

INSTRUCTION MANUAL

The instruction manual contained very little information on how to properly use the RDS Grain-O-Meter. It was more of a promotional brochure than an instruction manual. It is recommended that a clear, concise, instruction manual be supplied with the meter.

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:	Grain-O-Meter
Serial Number:	G7025
Electrical Power Requirements:	Two 9 V transistor batteries
Overall Height:	76 mm (3.0 in)
Overall Width:	130 mm (5.1 in)
Overall Length:	200 mm (7.9 in)
Total Weight:	1.86 kg (4.1 lb)
Principle of Operation:	resistance

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 RDS 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 and R = the dial reading of the RDS using the barley/oats dial scale. 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=0.64T+5.02	0.96	0.64	0.41	39	15.22
Barley	3	M=0.56T+5.21	0.94	1.08	1.16	16	14.09
Oats	4	M=0.58T+5.28	0.95	0.86	0.74	18	15.41
Wheat Humboldt	6	M=0.64T+5.11	0.97	0.64	0.41	20	16.15
Wheat Lethbridge	6	M=0.52T+6.55	0.92	0.65	0.42	6	13.40
Wheat Tempered	6	M=0.63T+4.94	0.95	0.68	0.46	13	14.63
Rapeseed Calibration	5	R=0.52T+9.30	0.95	0.61	0.38	8	15.19

(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 variation 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

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