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Group 7a

Evaluation Report 442

Agrofarm APS Grain Moisture Meter/Temperature Indicator

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

AGROFARM APS GRAIN MOISTURE METER AND TEMPERATURE INDICATOR

MANUFACTURER:

Agrofarm APS
DK-6064 Jordrop
Denmark

DISTRIBUTOR:

Robinson Alamo
1300 Waverly Street
Winnipeg, Manitoba
R3T 0P5

RETAIL PRICE:

$295.00 (March, 1986, f.o.b. Lethbridge, Alberta).

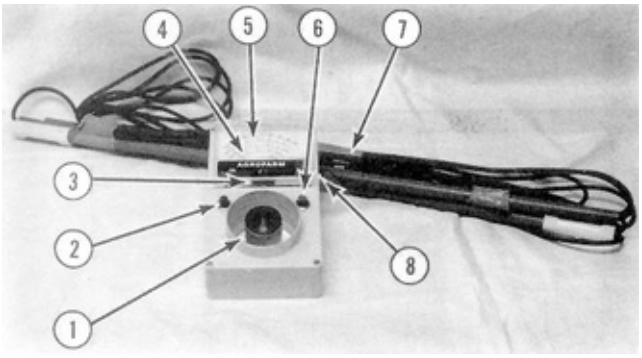

FIGURE 1. Agrofarm APS Grain Moisture Meter and Temperature Indicator: (1) Sample Chamber, (2) "Test Button", (3) Meter Zero Adjust, (4) Moisture Scales, (5) Temperature Scales, (6) Battery Check Button, (7) Temperature Probe and Extensions, (8) Moisture Adjust Screw.

SUMMARY

The accuracy of the Agrofarm in wheat was *very good* between moisture contents of 10.5 to 18.5%. The overall performance was, however, reduced due to inaccuracy, uncertainty and poor repeatability at higher moisture contents. Accuracy in barley was *very good* over a range of moisture contents from 10.5 to 17.5%. Overall performance was, however, reduced due to inaccuracy, uncertainty and poor repeatability above 17.5%. The accuracy in canola (rapeseed) was *very good* up to a moisture content of 10%. At higher moisture contents, the meter was inaccurate and uncertain.

The meter was easy to operate and a moisture measurement could be made in less than a minute. The meter was light and durable and was readily transportable for field use.

The operating instructions were clear and cdmplete, but written for a meter with different scales than the model tested.

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 temperature probe was accurate at 50°F but the error increased linearly to 20°F low at 210°F.

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GENERAL DESCRIPTION

The Agrofarm APS grain moisture meter 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.

The dial on the meter indicates moisture content directly on three scales for wheat, canola (rapeseed) and barley.

Sample weighing is not required. A large handful of grain is required to fill the sample chamber. Temperature compensation is performed automatically.

The meter is self-contained in a sturdy plastic case complete with carrying handle.

The test switches are spring loaded to avoid premature battery failure.

An external temperature probe, complete with a 33 ft (10 m) cable for use in grain bins, is also available. Temperature from 32 to 212°F is indicated directly on the meter.

The meter operates on a 9-volt transistor battery.

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

SCOPE OF TEST

The Agrofarm meter 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 300 measurements were made with the Agrofarm moisture meter. 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.

The accuracy of the external temperature probe was evaluated by comparing temperature readings from 50° to 210°F to that of a mercury thermometer in a water bath.

RESULTS AND DISCUSSION

EASE OF OPERATION

Moisture Measurement: The Agrofarm was easy to operate. A moisture measurement could easily be completed in less than a minute. The sample consisted of a large handful of grain to completely fill the sample chamber. No sample weighing was necessary and temperature compensation was automatic.

When the test switch was depressed, the dial readout displayed moisture content on three scales for wheat, canola and barley. Scale divisions were to the nearest one percent, requiring estimation of intermediate values. The temperature scale for the remote sensor was in increments of 10°F.

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. No warm-up period was required.

The 9-volt transistor battery was replaced after 260 readings. The battery was readily obtainable and easily replaced.

Field Use: The Agrofarm was light, durable and was self-contained in a sturdy plastic case with handle for convenient field use.

QUALITY OF WORK

Sample Size: Sample weighing was not required. Sample size consisted of filling the sample chamber until the grain was heaped over the central cone. The instructions warned against tapping the meter and compacting the sample. Tapping the meter had little or no effect on readings in dry grain but could re-

[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.

suit in achange in moisture content reading up to 0.8% in high moisture grain.

Temperature Compensation: The automatic temperature compensation was effective in dry grain. However, moisture content reading errors up to 2% low could occur for each 10°C below room temperature for damp grain. The user is cautioned to bring the meter and sample to room temperature for more accurate results.

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. These ranges include dry, tough and damp stages.

The scales on the Agrofarm meter indicated that it was capable of measuring moisture contents ranging from 9 to 26% for wheat, 10.5 to 23% for barley and from 6 to 17% for canola.

The Agrofarm 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 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 Agrofarm in wheat was very good over a range of moisture content from 10.5 to 18.5%. At 14.5% moisture content, the upper limit for dry wheat, the average meter reading was 0.1% high. This compared to a 0.4% low reading for the PAMI reference moisture meter. Below and above this range, average moisture content readings deviated considerably from true moisture content. Within this range of moisture contents, uncertainty was very good and repeatability was good. At higher moisture contents, repeatability was poor and the uncertainty was high.

The accuracy of the Agrofarm in barley was very good over a range of moisture contents between 10.5 and 17.5%. At 14.8% moisture content, the upper limit for dry barley, the average meter reading was 0.1% high. This compares to a reading of 0.5% low for the PAMI reference moisture meter. At moisture contents above 17.5%, meter readings were inaccurate, uncertain and repeatability was poor.

The accuracy of the Agrofarm in canola (rapeseed) over a narrow range from 6.5 to 10% was good. At 10.5% moisture content, the upper limit for dry canola, the average meter reading was 0.7% high while the PAMI reference moisture meter read 0.3% low. Up to 10%, uncertainty and repeatability were excellent. At higher moisture contents the meter was inaccurate and uncertain.

External Temperature Probe: The external temperature probe, when compared to temperature readings of a mercury thermometer in a water bath, was accurate at a temperature of 50°F. Above this temperature, the error increased in a linear fashion and was 20°F low at 210°F.

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 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. Note that changing the meter adjustment screw to change meter readings will alter the scales for all three grains as well as the temperature scale.

DURABILITY

The Agrofarm meter was durable and very well suited for field use. No problems were encountered with meter operation throughout the evaluation. Above 260 readings were taken before battery replacement was necessary.

OPERATOR'S MANUAL

The operating instructions were clear and complete, but apparently written for another model with a red temperature scale and a slightly smaller sample chamber.

APPENDIX I

SPECIFICATIONS

MODEL:	Agrofarm
SERIAL NUMBER:	08719
MANUFACTURER:	Agrofarm APS DK-6064 Jordrop Denmark
ELECTRICAL POWER REQUIREMENT:	One 9 V transistor battery
OVERALL HEIGHT:	2.9 in (73 mm)
OVERALL WIDTH:	4.7 in (119 mm)
OVERALL LENGTH:	9.1 in (232 mm)
TOTAL WEIGHT:	1.4 lb (639 g)
PRINCIPLE OF OPERATION:	Capacitance
SAMPLE SIZE:	6.2 fl oz (175 mi) (one 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 5. 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	FIGURE NO.	REGRESSION FORMULA	CORRELATION COEFFICIENT	STD. ERROR OF ESTIMATE	SAMPLE SIZE	SAMPLE MEAN
AGROFRAM APS						
Wheat, 10.5 to 18.5% m.c.	2	M = 0.94T + 0.97	0.98	0.49	12	13.87
Barley, 10.5 to 17.5% m.c.	3	M = 085T+ 2.27	0.99	0.26	10	13.83
Canola, 6.5 to 10% m.c.	4	M = 1.17T - 1.08	0.99	0.22	4	8.89
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

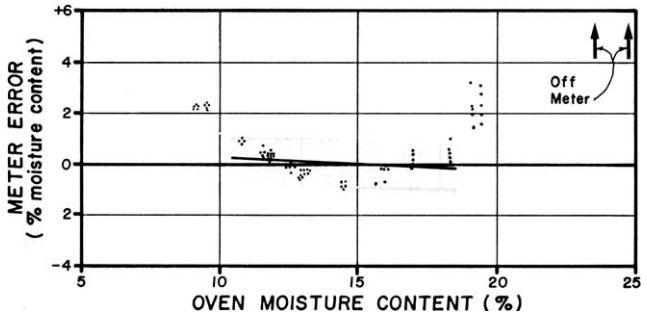

FIGURE 2. Accuracy of the Agrofarm Meter in Wheat.

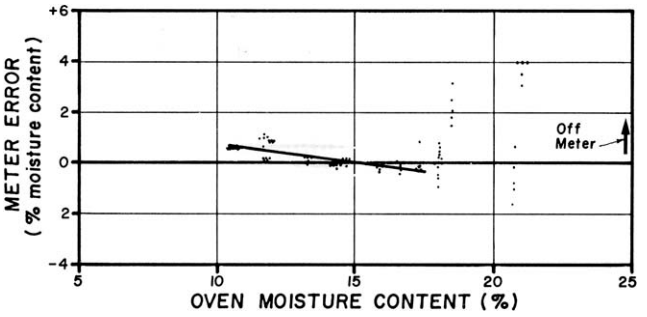

FIGURE 3. Accuracy of the Agrofarm Meter in Barley.

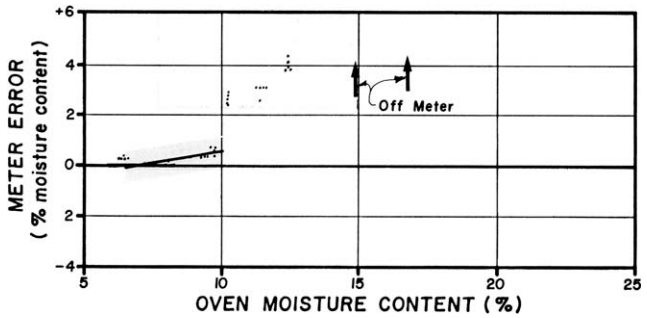

FIGURE 4. Accuracy of the Agrofarm Meter in Canola (Rapeseed).

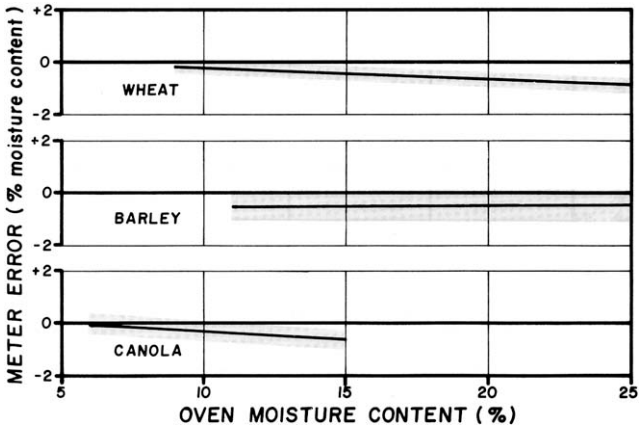

FIGURE 5. Accuracy of the PAMI Reference Moisture Meter in Wheat, Barley and Canola.

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)

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