

# Evaluation Report 215



## Koster Forage Moisture Tester

A Co-operative Program Between



ALBERTA  
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CENTRE



PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

# KOSTER FORAGE MOISTURE TESTER

## MANUFACTURER AND DISTRIBUTOR

Koster Crop Tester Inc.  
4716 Warrensville Center Road  
North Randall, Ohio  
44128 U.S.A.

**RETAIL PRICE:** \$200.00 (June 1981, f.o.b. Cleveland, Ohio, U.S.A.)



FIGURE 1. Koster Forage Moisture Tester.

## SUMMARY AND CONCLUSIONS

Overall functional performance of the Koster moisture tester was *excellent*. It indicated moisture contents within an accuracy of 3% of oven-dry moisture tests for chopped alfalfa and corn.

It was best to average measurements from several samples in each batch to reduce errors from moisture variation within the forage. This inconsistency in the forage itself varied from about 6% in chopped alfalfa and 8% in chopped corn. Averaging several measurements reduced the overall average error to within 0,8% in alfalfa and 1.3% in corn. Repeatability was *excellent* in both alfalfa and corn.

Operating ease was *good*. The Koster was unsuitable for field use due to the need for 120 V power source. The weigh scale had to be levelled and zeroed before the sample container was filled. Both operations were convenient. A single moisture determination took about thirty minutes.

Chief Engineer -- E. O. Nyborg  
Senior Engineer -- J. C. Thauberger  
Project Engineer -- R. R. Hochstein

## RECOMMENDATIONS:

No need for recommendations was apparent.

**Note:** This report has been prepared using SI units of measurement. A conversion table is given in APPENDIX III.

## GENERAL DESCRIPTION

The Koster forage moisture tester (FIGURE 1) is an evaporative type forage moisture tester. It determines moisture content by drying a forage sample of known mass and measuring the mass difference after drying.

The moisture content is determined directly from a weigh scale reading.

The system includes a sample container, a drying unit, and a weigh scale calibrated to provide simultaneous direct readings of both percent moisture content and dry matter.

The drying unit requires 120 V ac power which operates a heating element and fan. Detailed specifications are given in APPENDIX I.

## SCOPE OF TEST

The Koster was used to determine moisture contents of a variety of chopped alfalfa and corn forages. Readings were compared to moisture contents obtained using a standard oven dry method<sup>1</sup>. Samples were collected from a large number of fields at various stages of crop maturity. The moisture contents of four representative samples were measured from each batch. In total, more than 250 forage samples were tested.

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

## RESULTS AND DISCUSSION

### EASE OF OPERATION

**Portability:** The Koster was easy to use, however the need for 120 V AC power made it impractical for use in the field.

**Sample Selection:** One of the main problems in forage moisture measurement is obtaining a representative sample. The operator instruction recommended that samples be taken from different parts of a forage batch and mixed before measuring, to obtain a representative sample.

Best results were obtained using uniformly chopped forage samples of about 10 mm (0.5 in) cut length. Most samples taken from the discharge of forage harvesters were suitable. Standing or windrowed crop samples had to be chopped or cut before being tested. The operator instructions suggested suitable samples of 25 to 50 mm (1 to 2 in) lengths.

**Operating Procedure:** The weigh scale had to be placed on a flat surface and levelled, using the level indicator on the side of the scale. The empty sample container was then placed on the scale and the scale pointer adjusted to the black 100% mark on the dial face, using a thumbscrew under the scale platform. Forage was next added to the container until the pointer indicated 0% on the black scale. The container was then put on the drying unit, which was plugged into a 120 V AC outlet, for a prescribed drying time. Finally, the moisture content was determined by returning the sample container to the scale and reading the moisture content on the indicator. A single moisture measurement took about 30 minutes.

**Weigh Scale:** The weigh scale was calibrated to directly read both percent moisture (black scale) and percent dry matter (red scale).

**Drying Unit:** The forage sample was dried by hot air forced through the screen bottom of the sample container by the drying unit which consists of a heating element and fan. Ventilation had to be provided to dissipate the heat given off by the drying unit. Drying time ranged from 25 minutes for hay, to 35 minutes for silage of 65% moisture.

**Cleaning:** The Koster remained clean throughout the test.

### QUALITY OF WORK

**General:** Chopped forage is a non-uniform material. As detailed in the operator instructions, it was important to obtain a representative sample of forage for moisture determination. Since large variations in moisture content occur in the field, samples should be taken from several locations, within a batch of forage, to get a good indication of the average moisture content.

**Range of measurement:** The Koster was capable of moisture determination over the complete range of possible moisture content for all types of forage crops. It was evaluated with chopped alfalfa samples ranging from 20 to 76% moisture content and with chopped corn ranging from 34 to 72% moisture content.

**Accuracy:** An accuracy of 5% is an acceptable level for most purposes. The Koster performed well within this range. FIGURE 2 presents results for the Koster in chopped alfalfa. Each value was determined from an average of four readings on the same batch. The best fit line gives average results for 128 samples of chopped alfalfa collected in fields around Portage la Prairie.

<sup>1</sup>PAMI 77830 Detailed Test Procedures for Forage Moisture Testing Devices.

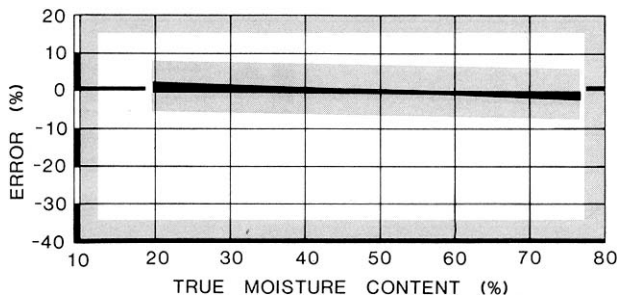


FIGURE 2. Accuracy in Chopped Alfalfa.

Average moisture readings were accurate at 40% moisture content and about 1% low at 70% moisture content.

FIGURE 3 shows the high degree of accuracy of the Koster in chopped corn. Average moisture readings varied from 1% high (at 34% moisture content) to 3% low (at 72% moisture content). Accurate readings occurred at about 45% moisture content.

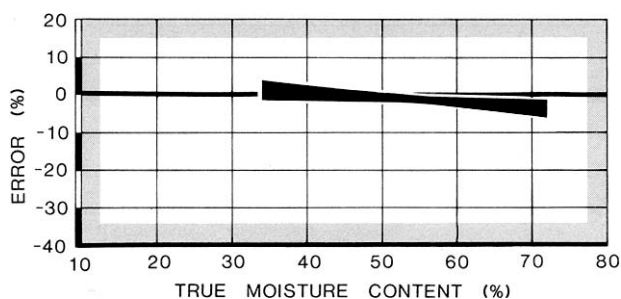


FIGURE 3. Accuracy in Chopped Corn.

**Uncertainty:** Uncertainty is indicated by the 95% confidence limits displayed by the width of the line in FIGURES 2 and 3. This uncertainty results from both sample variation and repeatability of the moisture tester.

The wide shaded area (scatter) indicated in FIGURE 2 shows the sample variation when only single measurements from a forage batch are taken. Averaging four readings in alfalfa reduced this uncertainty from 5.4% for single readings down to a scatter varying from 0.5% to 1.1%. Similarly, in corn, the uncertainty was reduced from 7.7% for single readings down to a scatter varying from 0.7 to 2.0% when averaging four readings. This difference shows the importance of averaging a number of readings when determining moisture content. The uncertainty with the Koster was due almost totally to variation within the forage itself.

**Repeatability:** Repeatability (APPENDIX II) is a measure of how consistently a tester gives the same reading if the same sample is measured several times. It indicates how subject the measurement method is to both operator error and instrument error. The repeatability of the Koster was excellent in both alfalfa and corn.

## OPERATOR MANUAL

Although no operator manual was provided with the Koster, a comprehensive outline of operation was provided on a set of cards. These operator instructions were easy to read and understand. They provided clear operating instructions and discussed sample selection procedures.

## APPENDIX I

### SPECIFICATIONS:

<i>Make:</i>	Kos[er]
<i>Electrical Power Requirements:</i>	
- voltage	110-120 V ac
- power rating	1200 watts
<i>Overall Dimensions:</i>	
- weigh scale	
- depth	100 mm
- width	120 mm
- height	145 mm
- weight	390 kg
- drying unit	
- diameter	190 mm
- height	300 mm
- weight	260 g
- sample container	
- diameter	180 mm
- height	130 mm
- weight	134 g
<i>Forage Sample Size:</i>	120 g
<i>Principle of Operation:</i>	evaporation

## APPENDIX II

**Moisture Tester Repeatability:** To eliminate the effect of sample variation, moisture tester repeatability was determined by relating the coefficient of variation (CV) of the tester to that determined with the oven drying method. The coefficients of variation were determined by expressing the standard deviation as a percent of the mean for each of the four samples taken from each forage batch. The values, 2.3% in alfalfa and 2.5% in corn, for the Koster; and 2.0% in alfalfa and 2.3% in corn, by the oven method, are the average coefficients of variation for all samples. The equation used to determine the repeatability of the tester was:

$$\text{Repeatability} = \frac{[(CV(\text{meter})^2 - (CV(\text{oven}))^2)]^{1/2}}{2}$$

Repeatability for the Koster was 1.1% in alfalfa and 1.0% in corn.

## APPENDIX III

### Conversion Table:

1 millimetre (mm)	= 0.04 inches (in)
1 kilogram (kg)	= 2.2 pounds mass (lb)

## APPENDIX IV

### 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



**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