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Standard Procedures for Foreign Matter and Moisture Analytical Tests Used in Cotton Ginning Research

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Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

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Standard Procedures for Foreign Matter and Moisture Analytical Tests Used in Cotton Ginning Research

By JACOB V. SHEPHERD, *research cotton technologist, Agricultural Engineering Research Division, Agricultural Research Service*

INTRODUCTION

The primary objective of preparing this handbook is to provide laboratory technicians of the Agricultural Engineering Research Division with a set of specific procedures to be followed in analyzing cotton samples for moisture and foreign matter content.

An additional objective, perhaps as important as the first, is to standardize the procedures for analytical tests at laboratories concerned with cotton ginning investigations.

Some of the tests and procedures described in this handbook are uniquely associated with cotton harvesting and ginning. Other tests are patterned after test methods developed and promulgated by the American Society for Testing and Materials (ASTM). These methods are not intended to supplant ASTM methods but rather to make the methods more suitable for ginning research needs.

PNEUMATIC FRACTIONATOR METHOD

Scope

The pneumatic fractionator method is used to measure the amount of foreign matter in a sample or lot of seed cotton. The large particles of foreign matter are removed by hand, whereas the smaller particles are removed in a machine that uses compressed air to tumble the specimen. The foreign matter is collected on a series of three screens.

Test Specimen

Either allow fractionation samples to come to moisture equilibrium before testing, or be sure the moisture content of the sample is 7 percent or less.

The specimen should weigh about 150 grams.

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Test Specimen

Either allow fractionation samples to come to moisture equilibrium before testing, or be sure the moisture content of the sample is 7 percent or less.

The specimen should weigh about 150 grams.

Equipment

- Balance, direct reading preferred, capacity 500 grams or more, sensitivity 0.1 gram.
- Fractionator, and three screens: 6, 50, and 200 mesh.
- Brush, soft bristle (2-inch paintbrush).
- Metal tray, 23 by 23 by 1 inch, one end open, 1 to 4 in number.
- Metal pan, 8 by 12 by 1 inch, 1 to 4 in number.
- Automatic timer.
- A compressed air supply capable of maintaining 70 p.s.i. when fractionator is in operation.

Procedure

Place the fractionation sample and the paper bag on a large scale pan, and record the weight to the nearest 0.1 gram.

Empty the specimen on a large metal tray, taking care to avoid loss of foreign matter in removing the sample. Shake the paper bag mouth down over the removed lot to obtain all the foreign matter in the sample.

Weigh the paper container to the nearest 0.1 gram, subtract the weight from the original sample and bag weight, and record on the laboratory fractionation sheet.

> *Note.*—For seed cotton foreign matter samples weighing more than 150 grams, the following procedure is recommended: About one-half of the entire large sample is spread thinly over the balance pan about 12 inches in diameter. The remaining one-half is then carefully spread over the first half. Any sifted trash in the large sample container is spread uniformly over the entire sample area. A portion of the sample consisting of about 150 grams is removed from the center by pulling the protruding seed cotton away from the pan and lifting the pan carefully in a vertical direction. The small sample of approximately 150 grams is weighed and the weight recorded.

Remove all large foreign matter from the test sample by hand before fractionation. If desired, separate the foreign matter as to kind, such as hulls, sticks and stems, and grass.

Place the remaining sample in the fractionator. Set timer for 75 seconds, and start the agitation with the compressed air at 70 p.s.i.

Collect and weigh the combined foreign matter on the three screens in the base of the machine, and record to the nearest 0.1 gram.

Weigh and record the large trash removed by hand, and record to the nearest 0.1 gram.

When percentages of each kind of foreign matter are desired, refractionate the material on the coarse screen; then pick out the motes and seeds on the coarse screen, weigh each group, and record the weights. After picking out the motes and seeds, separate the material left on the coarse screen by fractionation. Weigh the material on each screen and each kind of large trash separately, and record on laboratory sheet. The material on the top or coarse screen is classified as lint; the middle screen, as leaf; and the fine or bottom screen, as pin trash. Carefully remove all foreign matter from each screen with a small brush.

Weigh the cleaned seed cotton, and record the weight.

Calculations

Calculate the foreign matter content in percent as follows:

$$F = (F_h/S_o)\ 100 \qquad (1)$$

where F = foreign matter content
F_h = foreign matter picked out by hand in grams
S_o = original seed cotton weight in grams

$$F = (F_s/S_o)\ 100 \qquad (2)$$

where F = foreign matter content
F_s = foreign matter from fractionator screens in grams
S_o = original seed cotton weight in grams

$$F = (F_c/S_o)\ 100 \qquad (3)$$

where F = foreign matter content of one component
F_c = weight in grams of the component
S_o = original seed cotton weight in grams

Use equation 3 to calculate each component, such as sticks and stems, hulls, grass, leaf, motes, and pin trash.

Precision and Accuracy

Based on tests made with 10 observations on each lot, the expected precision in foreign matter percentages for seed cotton was as follows:

Foreign matter	Standard deviation	Coefficient of variation
Removed by agitation	0.5	12.0
Total removed by agitation and handpicking	.7	13.1

The number of observations (tests) required to detect specific differences between seed cotton samples at the 95-percent probability level was as follows:

Specific differences	Total foreign matter specimens	Foreign matter specimens removed by fractionator
Percent	*Number* [1]	*Number* [1]
0.3	28	14
.5	10	5
.7	5	3
.9	3	2

[1] $n = t^2s^2/d^2$

where n = number of specimens
t = probability factor (2.262 for 95-percent probability and and 9 degrees of freedom)
s = standard deviation in percentage points
d = difference to be detected

No justifiable statement on accuracy can be made because the absolute true value of foreign matter percentage in seed cotton cannot be established by an accepted reference method.

SHIRLEY ANALYZER METHOD

Scope

The lint foreign matter test method is used to determine the foreign matter content in a sample of lint cotton or processing waste using the Shirley Analyzer. This method is designed to obtain accurate lint foreign matter test results in the shortest possible time. This is accomplished by using smaller test specimens, one pass through the machine, and correction factors for determining lint foreign matter percentages.[1 2 3]

Test Specimen

Take four portions, each about the same size, from four widely distributed locations throughout the laboratory sample, and weigh a 50-gram specimen to the nearest 0.01 gram.[4] Do not blend or handle the laboratory sample in such a way as to cause loss of any foreign matter.

[1] SHEPHERD, J. V. NON-LINT CONTENT MEASUREMENT BY THE ONE-PASS SHIRLEY ANALYZER PROCEDURE. Textile Res. Jour., pp. 75–78. January 1961.

[2] STONEVILLE COTTON GINNING RESEARCH LABORATORY. ANNUAL REPORT—FISCAL YEAR 1970. P. 11. 1970.

[3] STONEVILLE COTTON GINNING RESEARCH LABORATORY. ANNUAL REPORT—FISCAL YEAR 1965. Pp. 12–14, 18. 1965.

[4] STONEVILLE COTTON GINNING RESEARCH LABORATORY. ANNUAL REPORT—FISCAL YEAR 1959. Pp. 105–110. 1959.

Conditioning

The samples should be conditioned to the atmosphere in the testing room (75° F. and 60-percent relative humidity) for at least 24 hours before testing.

Equipment

- Shirley Analyzer. See operating instructions for adjustment and maintenance in ASTM manual.
- Balance, capacity of at least 100 grams, sensitivity of 0.01 gram.
- Set of weights.
- Transparent case, 16 inches wide, 20 inches long, and 18 inches high, to enclose balance.

Procedure

Spread the test specimen as evenly as possible over the feed table. Large masses of fiber should be pulled apart to make an even batt.

Set the exhaust valve to obtain the minimum amount of lint falling into the waste (foreign matter) compartment and a minimum amount of foreign matter (waste) collecting with the lint on the condenser cage.

Clean the delivery box and waste compartment.

Start the machine and process the test specimen through the machine.

Collect the lint from the trash pan, shake lightly to remove the adhering trash, and process through the machine.

Remove the cleaned lint from the compartment, weigh to the nearest 0.01 gram, then weigh the waste from the foreign matter compartment to the nearest 0.01 gram and record the weight.[5]

> *Note.*—For total wastes ranging from 2.9 to 4.1 percent, research done in 1969 showed that 0.31 gram (0.16 gram exhaust lint and 0.15 gram moisture loss) should be added to the total clean lint weight to correct for moisture and lint loss during processing.[6]

Calculations

Calculate to the nearest 0.01 percent the total waste, visible waste, and lint content using equations 4, 5, and 6.[7]

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[5] See footnote 1.
[6] See footnote 2.
[7] See footnote 3.

$$T = (W - L)\ 2.23 \tag{4}$$

where T = total waste in percent
W = original specimen weight in grams
L = clean lint weight in grams

Note.—To calculate total waste percentage, subtract the clean lint weight in grams from the original 50 grams and multiply the results by 2.23, which is the equivalent of adding the correction of 11.5 percent to the total waste percentage.[8]

$$VW = V/W \times 100 \tag{5}$$

where VW = visible waste in percent
V = visible waste collected
W = original specimen weight in grams

$$LC = 100 - T \tag{6}$$

where LC = lint content
T = total waste in percent

Precision and Accuracy

The standard deviation and coefficient of variation for 10 total waste percentages on a large sample of lint, based on 1969–70 data,[9] are 0.3 percent and 7.3 percent, respectively. No justifiable statement on accuracy can be made because the true values are not known and cannot be established by an independent procedure.

The number of observations (tests) required to detect specific differences between samples at the 95-percent confidence level [10] was as follows:

Specimens	Total waste differences
Number	*Percent*
12	0.2
5	.3
2	.5

METHOD OF OVEN DRYING SEED COTTON

Scope

These methods cover the procedures for determining the amount of moisture in seed cotton by oven drying. When moisture is not

[8] See footnote 3.
[9] See footnote 2.
[10] See tabular footnote 1, p. 4.

the primary objective of the study, a 2-hour oven drying method with the formulas for calculating the moisture content may be used.

Equipment

- Oven, thermostatically controlled in the temperature range of 220° to 230° F., fan-forced ventilation, and, preferably, equipped with a balance that permits weighing the specimens without opening the ovens.
- Balance, of at least 100 grams capacity and a sensitivity of 0.01 gram, to weigh the specimens.
- Metal baskets, at least 3 inches in diameter by 6 inches high (75 mm. in diameter by 150 mm. high), for use in rectangular ovens equipped with revolving arms on which the baskets are hung. For specimens containing particles of foreign matter that are easily shaken out, use baskets made of wire screening fine enough to hold the trash, or line the lower part of the basket with metal foil, though this technique may prolong the drying period.
- Transparent case, 16 inches wide, 20 inches long, and 18 inches high.
- Set of balance weights.

Five-Hour Procedure

Weigh a seed cotton specimen of about 50 grams from an airtight container, and record the weight to the nearest 0.01 gram.

> *Note.*—Seed cotton containing at least 2 percent moisture will not change more rapidly than 0.1 percent per minute during exposure to air at standard temperatures and humidities. Open the container and weigh out the specimen of 50 grams, within 0.01 gram. If the specimen is adjusted to the specified weight in not more than 30 seconds after the container is opened, no appreciable error is introduced.

Place the specimen and the basket in the oven, and dry at 220° to 230° F. (105° to 110° C.).

Dry the seed cotton for at least 5 hours or until the change in weight between successive weighings at intervals of at least 1 hour is less than 0.1 percent of the specimen weight. Weigh to the nearest 0.01 gram and record the weight.

Calculate the moisture content as follows:

$$M = (W_o - W_d)/W_o \times 100 \qquad (7)$$

where M = moisture content
W_o = the original weight of the specimen
W_d = the specimen weight after oven drying

Two-Hour Procedure

Take a specimen of seed cotton from an airtight container, and weigh 50 grams to the nearest 0.01 gram on a balance in the glass case. (See previous note under "Five-hour Procedure.")

Place the weighed specimen in the wire basket, and put in the hot oven without delay to avoid an error due to change in moisture content before drying.

After 2 hours drying (while the basket is still in the oven), weigh to the nearest 0.01 gram and record.

Calculate the moisture content of seed cotton after 2 hours drying as follows:

$$Y = 0.66 + 2.25X \tag{8}$$

where Y = moisture percentage equivalent to 5 hours of oven drying

X = moisture loss in grams after 2 hours of oven drying

Precision and Accuracy

Based on tests made with 10 tests or observations on each lot, the expected precision in moisture percentages for seed cotton is 0.5 percent for the standard deviation and 6.4 percent for the coefficient of variation. No justifiable statement on accuracy can be made because the true value of moisture content in seed cotton cannot be established by an accepted reference method.

The number of observations (tests) required to detect specific differences between seed cotton samples at the 95-percent probability level is as follows:

Specific difference	Specimens
Percent	*Number*
0.3	15
.5	5
.7	3
.9	2

METHOD OF OVEN DRYING COTTONSEED

Scope

This method covers the procedure for determining the amount of moisture in cottonseed by oven drying for 5 hours and 10 hours.

Equipment

- Oven, thermostatically controlled in the temperature range of 220° to 230° F., fan-forced ventilation, and, preferably, equipped with a balance that permits weighing the specimens without opening the ovens.
- Balance, of at least 100 grams capacity and a sensitivity of 0.01 gram, to weigh the specimens.
- Metal perforated cups, 2½ inches in diameter and 2½ inches high, for use in rectangular oven equipped with revolving arms on which the cups are hung.
- Transparent case, 16 inches wide, 20 inches long, and 18 inches high.
- Set of balance weights.

Ten-Hour Procedure

Take a specimen of cottonseed from an airtight container, and weigh out 50 grams to the nearest 0.01 gram on a balance in the case.

> *Note.*—Cottonseed containing at least 2 percent moisture will not change more rapidly than 0.1 percent per minute during the exposure to air at standard temperatures and humidities. Open the container and weigh out the specimen of 50 grams. If the specimen is adjusted to the specified weight in not more than 30 seconds after the container is opened, no appreciable error is introduced.

Place the weighed specimen in the perforated cups and put in the oven for drying.

Dry the cottonseed for at least 10 hours or until the change in weight between successive weighings at intervals of at least 1 hour is less than 0.1 percent of the specimen weight.

Weigh the specimen, while the basket is still in the oven, to the nearest 0.01 gram and record.

Use equation 7 to calculate the cottonseed moisture content for 10 hours of oven drying.

Five-Hour Procedure

Take a specimen of cottonseed from an airtight container, weigh out about 50 grams to the nearest 0.01 gram on a balance in the glass case, and record the weight. (See previous note under "Ten-hour Procedure.")

Place the weighed specimen in the perforated cups, and put in the oven without delay to avoid an error due to change in moisture content before drying.

Weigh the cottonseed specimen, while the basket is still in the oven after 5 hours of drying, to the nearest 0.01 gram and record.

Calculate the cottonseed moisture content after 5 hours of oven drying as follows:

$$Y = 1.95X + 0.81 \tag{9}$$

where Y = moisture percentage equivalent to 10 hours of oven drying

X = moisture loss in grams after 5 hours of oven drying

Precision and Accuracy

Based on tests made with 10 tests or observations on each lot, the expected precision in moisture percentages for cottonseed is 0.4 percent for the standard deviation and 4.3 percent for the coefficient of variation. No justifiable statement on accuracy can be made because the true value of moisture content in cottonseed cannot be established by an accepted reference method.

The number of observations (tests) to detect specific differences between cottonseed samples at the 95-percent probability level is as follows:

Specific differences	Specimens
Percent	*Number*
0.3	9
.5	3
.7	2
.9	1

METHOD OF OVEN DRYING GINNED LINT

Scope

This method covers the procedure for determining the amount of moisture in ginned lint delivered to the laboratory.

Equipment

- Oven, thermostatically controlled in the temperature range of 220° to 230° F. (105° to 110° C.), fan-forced ventilation, and, preferably, equipped with a balance that permits weighing the specimens without opening the ovens.
- Balance, of at least 100 grams capacity and a sensitivity of 0.01 gram, to weigh the specimens in the containers that will be used.
- Metal baskets, at least 3 inches in diameter by 6 inches high (75 mm. in diameter by 150 mm. high), for use in rectangular

ovens equipped with revolving arms on which the baskets are hung. For specimens containing particles of foreign matter that are easily shaken out, use baskets made of wire screening or with openings fine enough to hold the trash, or line the lower part of the basket with metal foil, though this technique may prolong the drying period.

- Transparent case, 16 inches wide, 20 inches long, and 18 inches high.
- Set of balance weights.

Procedure

Take ginned lint specimens weighing about 20 grams from an airtight container. Weigh specimen to the nearest 0.01 gram on a balance in a glass case and record the weight.

> *Note.*—Lint containing at least 2 percent moisture will not change more rapidly than 0.1 percent per minute during exposure to air at standard temperatures and humidities. Open the container and weigh out the specimen of 20 grams. If the specimen is adjusted to the specified weight in not more than 30 seconds after the container is opened, no appreciable error is introduced.

Place the specimen in the perforated baskets and put in the oven for drying.

Dry ginned lint for at least 60 minutes or until the change in the weight between successive weighings at intervals of at least 15 minutes is less than 0.1 percent of the specimen weight.

Weigh the specimen, while the basket is still in the oven, to the nearest 0.01 gram and record the weight.

Calculations

Use equation 7 to calculate the lint moisture content after 60 minutes of oven drying.

Precision and Accuracy

Based on tests made with 10 tests or observations on each lot, the expected precision in moisture percentages for ginned lint is 0.3 percent for the standard deviation and 5.9 percent for the coefficient of variation. No justifiable statement on accuracy can be made because the true value of moisture content in ginned lint cannot be established by an accepted reference method. The number of observations (tests) required to detect specific differences between samples at the 95-percent probability level is as follows:

Specimens	Specific differences
Percent	*Number*
5	0.3
2	.5
1	7

METHOD OF OVEN DRYING COTTON WASTES

Scope

This method covers the procedure for determining the amount of moisture in cotton wastes by the oven drying method. Cotton waste is the material removed from seed cotton, ginned lint, or stock in process by any cleaning or processing machinery and is usually a mixture of seed cotton or cotton fibers with foreign matter.

Equipment

- Oven, thermostatically controlled in the temperature range of 220° to 230° F., fan-forced ventilation, and, preferably, equipped with a balance that permits weighing the specimens without opening the cans.
- Balance, of at least 100 grams capacity and a sensitivity of 0.01 gram, to weigh the specimens.
- Metal perforated baskets, at least 3 inches in diameter by 6 inches high (75 mm. in diameter by 150 mm. high), for use in rectangular ovens equipped with revolving arms on which the baskets are hung. Use baskets made of wire screening or baskets with openings fine enough to hold the waste, or line the lower part of the basket with metal foil, though this technique may prolong the drying period.
- Glass case, 16 inches wide, 20 inches long, and 18 inches high.
- Set of balance weights.

Procedure

From waste containing less than 50 percent lint cotton, cottonseed, or seed cotton, take specimens weighing 50 grams for the oven balance procedure. These specimens should come from an airtight container and be weighed to the nearest 0.01 gram on a balance in a glass case.

Note.—Waste containing at least 2 percent moisture will not change more rapidly than 0.1 percent per minute during ex-

posure to air at standard temperatures and humidities. Open the container and weigh out the specimen of 50 grams. If the specimen is adjusted to the specified weight in not more than 30 seconds after the container is opened, no appreciable error is introduced.

Place the specimen in the baskets, and put in the oven for drying.

Dry waste containing less than 50-percent lint cotton, cottonseed, or seed cotton for at least 5 hours or until the change in weight between successive weighings at intervals of at least 1 hour is less than 0.1 percent of the specimen weight.

Weigh the specimen, while the basket is still in the oven, to the nearest 0.01 gram and record.

Calculations

Use equation 7 to calculate the waste content of moisture.

Precision and Accuracy

Experience with this method is limited. Therefore, currently, well-established levels of expected precision are not available.

No justifiable statement on accuracy can be made because the true value of moisture content in waste cannot be established by an accepted reference method.

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