CROP GRADING
LABORATORY MANUAL
CROP GRADING

by

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INTRODUCTION

Crop Grading is a manual designed for a 2-hour weekly laboratory
given in connection with the Advanced Farm Crops course at Colo-
rado State College.

The commercial crop grades, which provide a single set of stand-
rards for the country as a whole, afford an excellent opportunity
for the student to learn crop quality. In many cases, the stand-
rards furnish quantitative as well as qualitative measures for the
evaluation of crop value.

The crops considered in this manual are: Wheat, corn, barley,
oats, rye, grain sorghums, flaxseed, and field beans.

ACKNOWLEDGMENTS

The writer wishes to acknowledge many helpful suggestions
offered by Mr. E. A. Hill and Mr. L. A. Hallam of the Federal
Inspection Service, Bureau of Markets, U. S. Department of
Agriculture, Denver, Colorado. The general outline of the
manual closely follows one prepared by Dr. T. E. Goodding of
the University of Nebraska.

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Exercise 1

Grain Class in Relation to Quality

I. Classes Under Federal Standards

Wheat may be defined as "any grain which, before the removal of dockage, consists of 50 percent or more of wheat and not more than 10 percent of other grains for which standards have been established under the provisions of the United States Grain Standards Act, and which, after the removal of dockage, contains not more than 50 percent of broken kernels of grain of any size. The term 'wheat' in these standards shall not include emmer, spelt, einkorn, Polish wheat, and Poulard wheat."

Under the Federal Grain Standards Act, wheat has been divided into seven commercial classes as follows: (1) Class I, Hard Red Spring Wheat; (2) Class II, Durum Wheat; (3) Class III, Red Durum Wheat; (4) Class IV, Hard Red Winter Wheat; (5) Class V, Soft Red Winter Wheat; (6) Class VI, White Wheat; and (7) Class VII, Mixed Wheat.

Commercial wheat is classified according to its qualities and uses. The amount and quality of the protein is one of the most important considerations in class distinctions.

II. Factors in Baking

Lightness in bread is due to the action of yeast which causes fermentation and consequent production of carbon dioxide. The carbon dioxide is held by the dough and gives porosity to the dough in proportion to the stickiness of the latter. Stickiness is due to the gluten in the wheat. Gluten content of wheat is closely associated with color, hardness, and texture. As one proceeds in the study of wheat, he will note that there are great variations in wheat of the same class, especially the red winter wheats, as to gluten content and bread-making qualities. Bread baked with flour made from certain classes of wheat will result in a loaf of good color and shape, fine texture, even grain, and excellent flavor, while wheat of the same class grown under different conditions may give a loaf gray in color, coarse-textured, poor flavor, and of poor shape.

III. Distinctions Between Wheat Classes

It is difficult to distinguish between some of the wheat classes, especially between Hard Red Spring and Hard Red Winter wheats, due to the intro-

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1Many ideas used in this outline came from the Grain Grading Manual, University of Nebraska.

Supplies necessary: Mortar and pestle, samples of the wheat classes (except mixed wheat).
duction of Ceres and Komar spring wheats. The most common commercial varieties may be described from Tech.Bul. No. 459, and from other information.

(a) Hard Red Spring Wheat
Marquis has been the most widely grown spring wheat, but in recent years it has been replaced quite extensively by Ceres and Komar. Hard red spring wheat kernels generally have a large germ, tufted brush (comes to point at tip), and open crease. (1) Marquis -- The kernels are red, short, hard, ovate, with truncate tip; germ mid-sized; crease wide, deep; cheeks angular; brush, mid-sized, mid-long (p. 69). The brush hairs come to a point, and the kernel is characteristically one-sided on the back. (2) Ceres -- The kernels are red, mid-long, hard, ovate; germ small; crease mid-wide, shallow to mid-deep; cheeks usually angular; brush mid-sized, short (p. 113). The Ceres kernel has a characteristic fine mark down the back. The germ is larger than that of Turkey, while the whole berry has a more rounded appearance. (3) Komar -- The berry is shorter, thicker, and smoother than that of Ceres, i.e.; it looks more like Marquis. The cheeks are angular and the brush end square. The kernel has a high back to the side of the center.

(b) Durum Wheat
The most important commercial variety is Kubanka. The kernels may be described as follows: White, large, hard, elliptical; germ mid-sized; crease mid-wide, shallow; cheeks angular; brush mid-sized, short (p. 142). The kernels have an amber appearance.

Sketches of Hard Red Spring Wheat Kernels

(Marquis)

Sketches of Durum Wheat Kernels
(c) Red Durum Wheat

Penob is the most widely grown Red Durum variety. Its kernels are red, mid-long, hard, ovate, truncate tipped, humped; germ mid-sized; crease mid-wide, shallow; cheeks angular; brush mid-sized, short (p. 139).

Sketches of Red Durum Wheat Kernels

(d) Hard Red Winter Wheat

The most important variety is Turkey. Practically all other winter wheats grown commercially are Turkey strains, among them being Kanred and Blackhull. The kernels of Turkey may be described as: Dark red, mid-long, hard, ovate to elliptical; germ small; crease narrow to mid-wide, mid-deep; cheeks rounded; brush small, mid-long (p. 106). The crease is straight in the Turkey types. The brush has no definite outline as in the hard red spring wheats.

Sketches of Hard Red Winter Wheat Kernels

(e) Soft Red Winter Wheat

The most widely grown varieties are Fulcaster, Fultz, and Poole. None of this class is grown in Colorado. The wheats in this class may be described in general to have a lifeless kernel color (tan-brown). The brush is similar to that of Turkey. Sometimes there are saw-edges on the angular cheeks (Marquis also has angular cheeks). The kernel is one-sided, and the germ sticks out. The suture is curved or irregular. The back of the kernel often drops down while that of hard red winter continues high. Important varieties may be described as follows: (1) Fulcaster -- The kernels are red, mid-long, soft, ovate, humped; germ mid-sized; crease mid-wide, mid-deep, sometimes pitted; cheeks usually angular; brush mid-sized, mid-long (p. 98). (2) Fultz -- The kernels are pale red, usually short, ovate; germ mid-sized; crease usually mid-wide, shallow to mid-deep; cheeks rounded to angular; brush mid-sized, mid-long.

Sketches of Soft Red Winter Wheat Kernels
(f) White Wheats

Some of the best known white wheat varieties are Goldcoin, Baart, and Hybrid 128.\(^1\) (1) Goldcoin — The kernels are white, short to mid-long, soft, ovate. The cheeks are usually rounded. A collared brush is distinctive (p. 76). (2) Baart — The kernels are white, long, semi-hard to hard, ovate, or obpyriform; crease narrow, shallow (p. 96). (3) Hybrid 128 — Kernels white, short, soft, ovate to oval, irregular, humped; crease shallow; cheeks angular, brush small.

![Sketches of White Wheat Kernels](image)

IV. Laboratory Instructions

1. Examine a few kernels of each class of wheat, and note the color, hardness and texture of each. The terms "vitreous", "medium", and "starchy" may be used to describe texture. It is advisable to cut the kernels with a knife in making the examination.

2. From each class of wheat (except mixed wheat) grind enough flour to make a 10-gram sample. After the 10-gram sample has been carefully weighed, place it in a round-bottom porcelain dish, add 6 cc. of water and mix into a stiff dough. Roll the dough into a ball, cover with water, and allow it to stand exactly one hour.

3. After the ball of dough has been allowed to stand under water for one hour, it should be carefully worked under a stream of water for exactly 14 minutes. It should then be removed and reworked between the fingers for one minute and thoroughly dried. Weigh the sample and fill in a form similar to the following:

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Kernel Color</th>
<th>Kernel Hardness</th>
<th>Kernel Texture</th>
<th>Glutn Content (Pct.)</th>
</tr>
</thead>
</table>

\(^1\)A large part of the Denver receipts are Dicklow and Federation.
4. During this period, the student can practice identification of the different classes of wheat. Secure samples of mixtures from the instructor. Separate the sample into its different classes, weigh each class, and fill in a form similar to the following:

**Outline No. 2**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Class</th>
<th>Grams</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

V. Questions to be Answered

1. What texture of kernel is best for macaroni? For pastry? For bread?
2. Lightness in bread is due to what?
3. Name the classes of wheat and arrange in order of importance (acreage).
4. Describe each class of wheat with regard to size, shape, and depth of suture of kernels. In this description, compare one class with another.
5. How can Hard Red Winter and Hard Red Spring wheats be distinguished?
7. What are the advantages of the federal grain standards?

**References**

1. Anonymous - *Handbook of Official Grain Standards of the United States (Revised)*
2. Bailey, C. E. *The Chemistry of Wheat Flour.* 1925
7. Swanson, C. C. *Meaning of Quality in Wheat.* Bull. Assoc. of Operative Millers, 928. 4
Exercise 2

The Sampling of Grain

I. Method to Obtain a Representative Sample

A correct and representative sample is an essential part of grain inspection. Otherwise, the true grade cannot be determined, regardless of the care used in making the determinations for the grading factors.

(a) The Grain Trier or Probe

For obtaining a representative sample from a carload of bulk grain, a double-tube, separate-compartment grain trier (probe) 60 inches long is recommended. The use of such a trier makes it possible for the sampler to note any unevenness in loading and also to ascertain the approximate location and quantity of any mixture of grain, or of dirty, smutty, heating, or damp spots, etc., found in any part of the grain. In order to assist in doing this, it is advisable to use a canvas 5 feet by 2 feet in dimensions on which to empty the grain from the trier. The grain should be emptied lengthwise on the canvas, each trierful separate from the other, so that the grain from each compartment can be noted separately.

The rules and regulations for the enforcement of the U. S. Grain Standards Act prescribe a definite procedure for securing a representative sample upon which the grade of any particular lot or parcel of grain is to be based. The rules are substantially as follows:

(1) The sample shall be approximately 2 quarts in size. If the time to elapse between the drawing of the sample and the determination of the grade would permit of such changes in the condition of the grain as to affect its grade, at least 1 1/8 pints should be enclosed in an airtight container and the remainder, if any, in a cloth bag;

(2) In the case of bulk grain in carload lots, trucks or wagon lots, or in any other container in which the grain is of about the same depth as in a carload, the sample shall be taken with a double-tube compartment, trier 60 inches long by probing flaxseed in seven or more places, and all other kinds of grain in five or more places, well distributed in different parts of such car, truck, or other container;

(3) In the case of bulk grain contained in a canal boat, barge, or steamship, the sample may be taken with a trier as described above, or with a longer trier of the same design, by probing flaxseed in seven or more places, and all other kinds of grain in five or more places, well distributed through each hatch or opening in the deck, provided such probing, or continued probing, will reach the grain at all depths;

Supplies necessary: Boerner sampler, grain pans, scales, 4 classes of wheat, oats, corn, shot, puffed rice.
(4) In the case of bulk grain being loaded on board a barge, boat, or steamship, the sample may be taken from the loading spout or other conveyor to the vessel by means of a device known as a "Pelican" or by means of any other device, approved by the Chief of the Bureau of Agricultural Economics or by a person designated by him for the purpose.

(5) In the case of grain contained in sacks, samples shall be drawn from as many individual sacks selected at random as will enable the procurement of a representative sample of all the sacks involved in the lot.

(b) The Boerner Sampler

After a representative sample of the lot or parcel of grain to be graded is obtained it is usually necessary to reduce its size considerably, in order that the grade may be determined by careful analysis. To reduce the size of a sample of grain containing foreign substances of different specific gravity or size than of the grain with which they are mixed, and at the same time obtain a sample as representative as the original, is hardly possible except by mechanical means.

In the operation of the Boerner sampler, the grain is placed in a hopper at the top of the machine and released, when it passes thru an opening at the bottom of the hopper, down the sides of a cone, the point of which is directly under the center of the opening. Around the base of the cone are 36 pockets or openings. The grain falling down the sides of the cone is cut into 36 separate streams. Streams Nos. 1, 3, 5, 7, etc., and Nos. 2, 4, 6, 8, etc., unite to form two separate streams that empty into separate receptacles.

II. Laboratory Instructions

1. Weigh out 25 grams of each: hard red spring wheat, hard red winter wheat, durum wheat, white wheat, oats, shot, corn, and puffed rice. Mix thoroughly by hand and take out approximately 40 grams, making the sample of the mixture as nearly representative as possible.

2. Make a separation of the sample and weigh each portion of the original accurately. Record the results in a form similar to the one at the latter part of this exercise.

3. Collect the entire mixture used above and run it thru the sampler, repeating the process until the sample has been reduced to approximately 40 grams. Make a separation similar to that called for previously, and record the results in a form similar to the one that follows:
III. Questions to be Answered

1. Compare the accuracy of the two methods for obtaining representative samples of grain.
2. Describe a grain trier and state the purpose for which it is used.
3. A sample for grading purposes should contain how much grain?
4. Why place 1 1/8 pints of grain in an air-tight container? When?
5. What is the purpose of the sampler or mixing device?

References

Exercise 3
The Moisture Test

I. Rapid Methods for Moisture Determination

The air-oven method of moisture determination is given as the basic method in the official standards for wheat, barley, oats, rye, grain sorghums, and flaxseed, while the water-oven method is specified for corn. Since these methods are slow, devices for rapid determination of moisture in grain have been developed to meet the routine requirements of practical inspection work. Grain inspectors are permitted to use electric moisture meters or other apparatus and methods so long as they give results equivalent to the oven methods.

The Brown-Duvel moisture tester was the official device for making moisture determinations for the official grain grades until July 1, 1935. Since that time, the electric moisture meter has been used also. The Brown-Duvel device requires 30 to 45 minutes for a single moisture determination. It is unnecessary to grind the sample when this method is used. The grain is placed in a flask, covered with oil, and heated to drive off the moisture. The moisture is condensed, collected, and measured to determine the amount in the grain. Certain modifications have been made in the procedure for the Brown-Duvel moisture tester to make the results check more closely with the oven methods and the electric moisture meter. It is still more reliable than the latter for moisture tests in corn when the moisture content of the sample is not uniform.

The Tag-Heppenstall moisture meter\(^1\) is the official device now in use in federal grain supervision offices. The tests with this device, with but few exceptions, check more accurately with the tests made by oven methods than the tests made by the Brown-Duvel moisture tester. This moisture meter is calibrated for wheat, corn, oats, barley, rye, sorghums, rice, soybeans, and vetch. The electric moisture meter has certain advantages for practical work: (1) It is unnecessary to clean after each sample, (2) the sample is not weighed, (3) a single determination can be made in less than one minute, (4) it will duplicate results within a tolerance that cannot be met in a single determination by other methods, and (5) the operation and maintenance cost is low.

II. Description of the Brown-Duvel Tester

The apparatus consists of a heating chamber divided into compartments so that a number of samples can be tested at the same time, a tank for cold water, through which the condenser tubes pass, a stand to support the heating chamber and cold water tank, and numerous accessories, such as thermometers, distillation flasks, graduated measuring cylinders, etc., all of which will be discussed in detail in the procedure of making the test.

\(^1\)C. J. Tagliabue Mfg. Company, Park and Nostrand Avenue, Brooklyn, New York.
III. Method to Make Moisture Test

1. Carefully weigh the desired quantity of grain, as indicated in the table, and empty into the glass distillation flask, to which add the oil by pressing the mouth of the flask against the trip of the automatic oil measuring device. With a slight whirling motion, rotate until the two become well mixed. Grasp the neck of the flask in one hand and hold it in such a manner that when the No. 5 rubber stopper carrying the thermometer is inserted it can be readily determined whether the mercury bulb of the thermometer is properly adjusted in the oil. The mercury bulb should be four-fifths immersed in the oil. Note whether or not the column of mercury is continuous, if broken it should be shaken down.

2. As the thermometer is being inserted, glance along the side of the flask to make certain that the side tube, leading to the condenser, has not become stopped by the lodgment of some particle while emptying or filling the flask. If the tube is not open to permit the free escape of the rapidly forming steam, the pressure during the heating will become sufficient to blow out the stopper and thermometer, or possibly to burst the flask.

3. When the flask has been filled and placed in the compartment of the tester, connect the side tube of the flask by means of the No. 3 rubber stopper with the thimble of the glass condenser tube which extends down through the cold water tank. The moisture which is liberated from the grain will be condensed and collected in the graduated cylinder beneath the tank.

4. Place the cover over the flask, see that the electrical burner, which is swung from a hinge, is held firmly to the rear wall of the heating chamber, and turn on the current. When the desired temperature is reached, as indicated in the table, turn off the current, after which a slight gradual increase in temperature will occur. It will require about twenty minutes to reach the prescribed temperature. If the sample contains a large percentage of moisture, there is danger of boiling over but this can usually be prevented by turning off the current whenever the action in the flask becomes too vigorous, as can be readily observed through the mica window of the compartment. As soon as the water stops dropping from the condenser or when the mercury drops to $160^\circ$, which usually requires from four to six minutes after the heat has been turned off, the test is complete. However, before reading the amount of moisture, remove the cover and then disconnect the flask from the condenser tube in order to allow the small quantity of moisture which sometimes collects at the base of the No. 3 rubber stopper to drop in to the graduate.

5. In making moisture tests, use the quantities of oil and grain and extinguish the flame as listed in the following table of specifications:
<table>
<thead>
<tr>
<th>Kind of Grain</th>
<th>Oil in Flask (Cc)</th>
<th>Weight of Grain in Flask (Grams)</th>
<th>Extinguish the Flame at °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft red winter wheat</td>
<td>150</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>White wheat</td>
<td>150</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>Other wheats</td>
<td>150</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>Shelled corn</td>
<td>150</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>Oats, Feed oats, and Mixed feed oats</td>
<td>150</td>
<td>100</td>
<td>195</td>
</tr>
<tr>
<td>Rye</td>
<td>150</td>
<td>100</td>
<td>185</td>
</tr>
<tr>
<td>Grain sorghums</td>
<td>150</td>
<td>100</td>
<td>195</td>
</tr>
<tr>
<td>Berley</td>
<td>150</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>Flaxseed</td>
<td>150</td>
<td>100</td>
<td>175</td>
</tr>
<tr>
<td>Head rice (milled)</td>
<td>150</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Second head rice</td>
<td>150</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Screenings rice</td>
<td>150</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Brewer's rice</td>
<td>150</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Brown rice</td>
<td>150</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>Rough rice</td>
<td>150</td>
<td>100</td>
<td>190</td>
</tr>
</tbody>
</table>

6. The small graduated cylinder for measuring the moisture has a capacity of twenty-five cubic centimeters and is graduated in fifths, so that the readings can readily be made in tenths, when one hundred grams of grain is used for the test, the number of cubic centimeters of water in the graduate corresponds to the percentage of moisture originally contained in the sample since one cubic centimeter of water weighs one gram. The percentage of moisture is read beneath the layer of oil on top of the water. Should the oil and water not separate readily, the graduate should be whirled by rolling quickly between the two hands. If the water which distills over is discolored, the substance has evidently been burned, and the test should be repeated.

7. While the contents of the flask are still hot, take the flask by the neck and after giving a slight whirling motion invert quickly, emptying the contents into the strainer, so that the oil can be recovered for further use.

8. When the flask is not in use, keep it in place in the compartment, with all connections made as for making a test. The graduate should be cleaned thoroughly with a swab and placed on the rack.

IV. Special Points for Consideration

1. The moisture tester should be installed in a place where it will not be exposed to strong air current.
2. The standard tester is equipped for heating with illuminating gas.
3. The wire gauze with asbestos center should be kept in good condition, and so adjusted that the flame plays directly in the center of the asbestos.

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4. The bottom of the flask should be not less than three-eighths inch above the wire gauze.
5. The column of mercury in the thermometer should be continuous; if broken, it should be shaken.
6. The sample should be thoroughly mixed before weighing for tests; and unless the test is to be made immediately upon its arrival in the office, it should be placed in an air-tight container.
7. Tests should be made in duplicate, and if duplicates vary over 0.3 percent another test should be made.
8. The thermometers should be so adjusted that four-fifths of the mercury bulb is submerged in the grain and oil after the grain has been placed in the flask. (See to the adjustment each time. Do not guess.)
9. Correctly graduated thermometers and graduates should be used.
10. Mushy rubber stoppers must not be used as they absorb some of the moisture that should pass into the graduates.
11. Each graduate should be cleaned and dried before using for a test. (Do not let them show any moisture in the bottom or along the sides.)
12. Oil should not be used directly from the previous test. Used flasks should be emptied into a large storage can and never directly into the oil-measuring device.
13. A good circulation of cold water should be maintained through the condenser tank.
14. The heating apparatus should be so adjusted that the required temperature is reached in 20 minutes. A longer time will give results too low and a shorter time, too high.
15. If the moisture content of the sample is high so that there is a tendency to boil over, the flame should be lowered until a considerable portion of the water is distilled over.
16. The heat should be cut off at the exact temperature prescribed for each grain.
17. After the flame is extinguished, a slight gradual rise in the temperature is to be expected. A sudden increase or sudden decrease in temperature of several degrees indicates that the flame was too intense during the latter part of the heating, and the test should be repeated.
18. Covers and thermometers should not be removed until the temperature recedes to 160°C.
19. After the temperature has fallen to 160°C. or lower, the thermometer is disconnected and then the delivery tube.
20. The percentage of moisture in the graduated cylinder should be read after all the drops clinging to the sides of the graduates have been shaken down. The reading is taken beneath the layer of oil on top of the water.
21. Results of tests need not be expressed more closely than 0.1 percent.
22. If the water which distills over is discolored, the substance has evidently been burned and the test should be repeated. (Note exception to this in the case of rice.)
23. When machine is not in use, thermometers should be kept connected in the flasks and the flasks connected with the distilling tubes in the same manner as for making a test.
24. Before making a test in new flask, or before using a machine that has not been in use for a 24-hour period, a test should be made on a preliminary sample so that all the flasks will be uniform in condition.
25. Scales should be placed on a firm support and care should be taken that they are in balance before making a weighing.
26. The specific directions given above for making tests do not apply to modified forms of testers.
V. Laboratory Instructions

1. After the previous material in this exercise has been studied, obtain a sample of Hard Red Winter wheat from the instructor, and test it for moisture.
2. Make a determination for some other kind of grain, e.g., shelled corn, oats, or barley.
3. Record your results and turn them in with the other written work in this exercise.

VI. Questions to be Answered

Note: The student will be expected to describe the operation of the Brown-Duvel moisture tester in detail for any examination.

1. Why has the oil method been used for moisture determinations in commercial work rather than the oven methods?
2. If 100 grams of grain is used, why does one cubic centimeter of water equal one percent?
3. How do you know when to turn off the heat?
4. How long should it take from the time the heat is turned on until it is turned off?
5. Why is 150 cc. of oil used?
6. How much moisture is permitted in the different classes of wheat before the special grade "Tough" is required?
7. Why have a different turning-off temperature for each of the following: corn, wheat, oats?
8. What advantages does the electric moisture meter have over the Brown-Duvel device? Disadvantages?
9. How does combine harvest of wheat affect the moisture content of wheat? Grades?

References


(7401-40)
I. Definition of Dockage

"Dockage (e.g. for wheat) includes weed seeds, weed stems, chaff, straw, grain other than wheat, sand, dirt, and any other foreign material, which can be removed readily from the wheat by the use of appropriate sieves and cleaning devices; also undeveloped, shrivelled, and small pieces of wheat kernels removed in properly separating the foreign material, and which cannot be recovered by properly rescreening or recleaning.

"The quantity of dockage shall be calculated in terms of percentage based on the total weight of the grain including dockage. The percentage dockage so calculated, when equal to 1 percent or more, shall be stated in terms of whole percent, and when less than 1 percent shall not be stated. A fraction of a percent shall be disregarded. The word 'dockage', together with the percentage thereof, shall be added to the grade designation." (Handbook of Official Grain Standards)

Dockage can be determined for all grains by the use of the proper sieves without supplementary equipment. The use of the Emerson Kicker replaces certain sieves. Recently, the Federal Dockage Tester has been perfected. It replaces practically all sieves, and reduces dockage determination to a purely mechanical basis.

II. Equipment for Sieving Procedure with Emerson Kicker

(a) Supplementary Machine Equipment

The equipment to be used with the Emerson Kicker consists of:

1. A No. 1 riddle for removing coarse dockage in hard red spring and small-berried club wheats.
2. A No. 2 riddle for removing coarse dockage in all wheats other than hard red spring and small-berried club wheats.
3. A step-metal riddle having round-hole perforations 1 1/64 inch in diameter for the determination of "cracked corn and foreign material" in corn and for the removal of coarse dockage in Western barley.
4. Three flat sieves for use in the bottom of the machine identified as follows: (1) A 20-gage metal sieve with round-hole perforations 1/12 inch in diameter (fine-seed sieve); (2) a 20-gage metal sieve with equilateral triangular perforations the inscribed circles of which are 5/64 inch in diameter (small buckwheat sieve); (3) a 20-gage metal sieve perforated with equilateral triangular perforations the inscribed circles of which are 0.089 inch in diameter (large buckwheat sieve).

(b) Hand-Sieving Equipment

The following hand sieves are needed to supplement the machine riddles and sieves of the Emerson Kicker:
1. A 20-gage metal sieve perforated with round holes 2 3/64 inch in diameter (grain-sorghums dockage sieve).

1 Manufactured by the Leach Company, Oshkosh, Wisconsin.
2. A 20-gage metal sieve perforated with round holes 1/12 inch in diameter (fine-seed sieve).

3. A 20-gage metal sieve perforated with round holes 4 1/2/64 inch in diameter (flaxseed sieve).

4. A 20-gage metal sieve perforated with equilateral triangular perforations the inscribed circles of which are 5/64 inch in diameter (small buckwheat sieve).


6. A 20-gage metal sieve with slotted perforations 0.064 inch wide and 3/8 inch long (small chess sieve).

7. A 20-gage metal sieve with slotted perforations 0.070 inch wide and 1/2 inch long (large chess sieve).

8. A 20-gage metal sieve with slotted perforations 0.076 (4 7/8 / 64) inch wide and 3/4 inch long (barley-sizing sieve).

9. A bottom pan in which the hand sieves will nest freely.

(c) Boerner Sampler

The Boerner sampler shall be used always for the purpose of obtaining representative portions of samples for the dockage determinations.

---

III. Operation of the Emerson Kicker

On account of the peculiar short, jerky motion of the riddle, this machine has been popularly called the "Wild Oat Kicker."

Two sets of riddles are used in the machine, one set for separating wild oats from spring wheat and the other for separating wild oats from rye, durum and winter wheat. The spring wheat riddle contains the smaller mesh.

The separation is made by the length of the kernel. The oats, being longer, cannot follow the short kernels through the double angle construction of the riddles. The short kernels (wheat, barley, or rye) pass through the angles very freely, but the oats cannot follow. The peculiar motion of the riddles lifts the end of the oat up into the little angle leaving the oat free; then the motion of the riddle forces it out and up until it is discharged over the end into the container.

After the oats have been removed the remainder of the grain and dockage pass down over a fine seed sieve which allows the dockage to drop into one box and the grain into the other.

In summing up the process, we might say that the sample, after being run through the kicker, is divided into three parts as follows: (1) The wheat passes through the riddle and after passing over the screen is discharged into a box by itself. (2) The oats and large foul seeds cannot pass through the riddle, so are discharged over the riddle into a receiving box. (3) There is a drawer under the lower screen which catches all the dirt and fine foul seed. This portion should be rescreeened over the "fine seed" sieve.

---

IV. Method for the Determination of Dockage in Wheat

(a) Instructions for Use of Emerson Kicker

1. Use a representative portion of the original sample of sufficient quantity
to provide at least 1 1/2 quarts of dockage-free grain for the test-weight determination.

2. Each sample of wheat which contains barley, oats, wild oats, or other similar coarse material, shall be run twice through the single-riddle Emerson Kicker but only once through the double-riddle Kicker.

3. In case of hard red spring or small-berried club wheats, use the No. 1 riddle in the machine. In case of all other wheats, use the No. 2 riddle.

4. Use the 1/16-inch round-hole sieve as the bottom sieve in the machine, except in cases where: (a) the wheat (original sample) contains more than 0.3 percent (an excess quantity) of wild buckwheat, or more than 0.3 percent (an excess quantity) of wild buckwheat and other weed seeds of similar size and shape; (b) the wheat (original sample) contains more than 0.3 percent (an excess quantity) of cob joints and chaff (rachis material). For these exceptions use the 0.089-inch (diameter of inscribed circle) triangular-perforation sieve (large buckwheat sieve) in the bottom of the machine with the wide end of the perforations facing the feed end of the machine.

5. All threshed kernels that are kicked over the riddle with the coarse dockage shall be picked out and put in the cleaned sample.

(b) Reclaiming Wheat with Hand Sieves

In all cases except wheat containing excess wild buckwheat, etc., or wheat containing excess cob joints, etc., the material which passes through the 1/12 inch round-hole sieve in the bottom of the Emerson Kicker shall be rescreened over the hand sieve having 1/12-inch round-hole perforations in order to reclaim wheat.

In those cases where wheat contains either an excess quantity of wild buckwheat, etc., or an excess quantity of cob joints, etc., the material which passes through the 0.089-inch triangular-perforated machine sieve shall be rescreened over the hand sieve having 5/64-inch triangular perforations in order to reclaim wheat.

In this rescreening process place not more than 50 grams of the material on the sieve at the upper edge; then, holding the sieve at an angle of 10 to 20 degrees, work the material down over the sieve by a gentle sidewise-sieving motion in such a manner as to reclaim the wheat. (A second rescreening of the material that passes through the hand sieve may be necessary, but in no case shall the material be rescreened more than three times.)

If at any time during the reclaiming procedure the material remaining on top of the hand sieve consists of more than 50 percent of dockage material, it shall be considered as dockage and no further reclaiming shall be done.

After making dockage determinations by the above methods, the dockage will consist of all coarse material except wheat that passes over the riddle, all fine dockage passing through the hand sieves in the process of reclaiming, and the material remaining on top of the hand sieve when such material consists of more than 50 percent of dockage material.
(c) Supplementary Sieving of Wheat Containing Chess

In case of wheat, which on the basis of the original sample contains more than 0.5 percent chess and/or quack grass and/or other weed seeds of similar size and shape, and from which dockage has been separated by the use of the riddle and both the machine and hand 1/12-inch round-hole sieves, the wheat so cleaned shall be screened further with either the large or small chess hand sieve according to which of these sieves is best suited to remove the chess, etc. Place approximately 250-gram portions of the sample at a time on the hand sieve to be used, working it back and forth lengthwise with the slots until all of the removable material has passed through the sieve. Continue the operation until the entire sample has been sieved.

The wheat remaining in the material passing through the hand chess sieve shall be reclaimed in the following manner: Using the hand sieve having 1/12-inch round-hole perforations (fine-seed sieve) held at an angle of from 10 to 20 degrees, place the material on the lower edge of the sieve and strike the lower edge of the sieve with one hand in such a manner as to cause the material to bounce up and down. This will cause the chess, etc., to up-end and pass through the perforations of the sieve. Continue the operation until all of the separable dockage material has passed through the sieve.

The material remaining on top of the "fine-seed" hand sieve shall be returned to the cleaned wheat. If the material which passes through this sieve consists of 50 percent or more of whole or broken kernels of wheat, it shall be put back in the cleaned wheat; otherwise, it shall be added to the dockage previously obtained.

(d) Reccreening of Wheat Containing Flaxseed

There are occasional cases where wheat, particularly hard red spring or durum wheat, contains flaxseed after the removal of dockage material by the methods heretofore described. In all such cases the flaxseed shall be separated from the cleaned wheat by the use of a 3/54-inch by 3/8-inch slotted-perforation hand sieve, or a 0.054-inch by 3/8-inch slotted-perforation hand sieve, according to which sieve is most appropriate in relation to the size of the wheat and flaxseed kernels in the sample.

The flaxseed and other dockage material removed by this procedure shall be added to the dockage.

V. Laboratory Instructions

1. Procure samples of wheat from the instructor.
2. Weigh, run first through the Emerson Kicker, and then over the proper sieves.
3. Reweigh total dockage, compute the percent, and record in a form similar to the one below. After each percent of dockage, indicate the kind, whether chess, wild buckwheat, fine seed, etc.
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Pct. Dockage</th>
<th>Kind of Dockage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VI. Questions to be Answered

1. How would you determine dockage on a wheat sample without an Emerson Kicker?
2. Explain in your own words how the dockage test is made with the Emerson Kicker.
3. Why is dockage calculated separate from foreign material?
4. What are the causes of dockage?
5. How does the farmer gain by cleaning grain before it is marketed?
6. What advantages can you see for a dockage tester that does away with the necessity for hand sieves?

References

Exercise 5

Test Weight per Bushel

I. Reasons for Test Weight

The best known method by which plumpness and fall maturity of any grain can be measured is by the test weight per bushel. Matured plump kernels will show a higher test weight per bushel than will smaller shrivelled kernels. It has been found in corn that mature corn has a higher bushel weight than that harvested in the field in immature stages. More valuable products can be produced from grain of high test weight than from grain of low test weight per bushel. Therefore, test weight is one of the important factors in the several grades of the federal standards. (Miller, et al., 1930).

II. Standard Method for Test Weight

The conditions given in the method described below have been found to be essential for uniform tests of weight per bushel and obtaining accurate results, and have been adopted as standard in connection with the enforcement of the United States Grain Standards Act:

1. Use an accurate quart-sized tester.
2. Fill the kettle from a hopper.
3. Opening at bottom of hopper must be round and exactly 1 1/4 inches in diameter.
4. Bottom of opening must be held exactly 2 inches above center of kettle.
5. Mark hopper on inside at a point where it will hold just sufficient grain to cause overflow over all sides of kettle.
6. Use same volume of grain for each test.
7. Use a stroker made of hardwood with smooth rounded edges, 12 inches long, 3/8 inch thick, and 1 3/8 inches broad.
8. Place the stroker on the edge of the kettle lightly without jarring the kettle.
9. Stroke the grain from the kettle with three full-length zigzag motions of the stroker.
10. Hold the stroker on the kettle with its sides held in a vertical position.
11. Make the stroke clean all the way across the kettle.
12. Have the kettle rest on a firm base.
13. Do not jar the kettle before or during the stroking operation.
14. If the top of the kettle is rough, smooth down the roughness with a rounded metal bar, but do not use a file for the purpose.
15. Make the test immediately after the sample has been brought to the inspection room, office, or laboratory, to prevent drying out of the grain with consequent change in its test weight.
16. The quart kettle must have a capacity of exactly 67.2 cubic inches.
17. Use a beam which is both accurately graduated and sensitive to one-tenth pound per bushel.
18. Have the grain tester tested periodically for: (1) Accuracy of kettle, (2) accuracy of beam readings, and (3) sensitiveness of beam. (See Dept. Bul. 1065, U.S.D.A.)

1Taken from Handbook of Official Grain Standards of the United States.
III. Basis of Determination for Test Weight

The official standards provide that the determination of the test weight per bushel in the case of wheat, rye, and barley shall be made upon the basis of the grain from which the dockage has been removed; in the case of flaxseed the test-weight determination shall be made upon the basis of the flaxseed after the removal of that part of the dockage which can be removed readily by the use of appropriate sieves and cleaning devices; and in the case of all other grain the test weight determination shall be made upon the basis of the grain as a whole.

As the test weight per bushel is one of the main factors in determining the grade of grain, 1 1/8 quarts of the grain should be available to permit the test weight to be made with a quart tester.

IV. Laboratory Instructions

1. Use the old method for test weight per bushel. Push the kettle down into a sample of wheat, from which the dockage has been removed. Fill the kettle by pouring the grain in with the hands. Strike the excess grain from the top of the overflowing kettle with the beam of the tester. Repeat the process as many times as called for in the form at the end of the exercise. Record the results.

2. Fill and stroke off the special cup to be used with the "four-in-one" test in the same manner as in the old method. Weigh contents on the "four-in-one" scales. Record.

3. Take the bushel weight with the small hand tester (used by judges at fairs, etc.) Pour the grain in a steady stream from a height of four inches from a tin cup until the kettle runs over. Stroke the grain from the top of the kettle in 3 zig-zag motions with the beam. Weigh and record the results.

4. Now follow the procedure as prescribed in the Grain Standards Act for determination of the test weight per bushel, and record the results in a form as follows:

<table>
<thead>
<tr>
<th>Trials</th>
<th>Old Method (Lbs.)</th>
<th>Four-in-one Method (Lbs.)</th>
<th>Hand Tester (Lbs.)</th>
<th>Official Method (Lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>5</td>
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<tr>
<td>Average</td>
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<td></td>
</tr>
</tbody>
</table>
V. Questions to be Answered

1. Analyze the data obtained. Which method is the most accurate? Why?
2. Explain under what conditions the farmer would gain by the use of the old method. The miller.
3. What effect would it have on the accuracy of the Standard Method were the table leg kicked before the bottle were stroked? 
4. What factors may cause errors in the bushel weight determination?
5. What is the difference between "test weight per bushel" and the term "legal bushel"?

References

Exercise 16

Various Separations in Grading: Wheat

I. Factors Determined by Hand Separations

So far, grain grading has been almost entirely a mechanical process. The remainder of the grading factors are qualitative and involve the judgment of the student. Hand separations are made to determine: (1) damage, (2) foreign material, (3) color and texture, and (4) wheat of other classes. Wheat of special limitations is also determined by hand separations.

(a) Damaged Kernels

These include kernels and pieces of kernels of wheat and other grains which are heat damaged, sprouted, frosted, badly ground damaged, badly weather damaged, or otherwise materially damaged. Sprouted kernels should be those that either show sprouts, or have the bran layer on the germ broken. Frosted kernels have transverse ridges on the back of the kernel.

Heat damaged kernels are those which have been materially discolored and damaged by external heat or as a result of heating caused by fermentation. This is caused by wheat being stacked green or wet, or stored before dried out enough for safe storage. Intramolecular respiration takes place in the kernels and heat develops. Its action is accelerated as the temperature rises. Heat-damaged wheat is characterized by discoloration of the kernel. The color depends on the severity of the fermentation or heating process. The kernels change from their natural color, passing from light yellow or amber thru various shades of dark yellow and brown to a deep brown or red mahogany color in the most extreme condition of heat damage. As small an amount as one percent of heat-damaged wheat mixed with sound wheat will result in a flour of inferior quality.

(b) Foreign Material

Foreign material consists of all matter other than wheat which is not separated from the wheat in the proper determination of dockage, except that smut balls shall not be considered as foreign material. It is divided into two parts: other grains, and other foreign material.

In wheat, foreign material is usually composed of cockle, wild peas, wild buckwheat, wild rye seeds, chen, etc. This material reduces the quality of the flour milled from wheat that contains it.

Other grains in wheat consist of rye, oats, corn, grain sorghums, barley, hulless barley, flaxseed, emmer, spelt, einkorn, Polish wheat, Poulard wheat, cultivated buckwheat, and soybeans.

(c) Color and Texture

In hard red wheats, some lots are very high in protein. This is well indicated by the proportion of dark, hard, and vitreous kernels found in the sample. Bottled or chalky-textured kernels are usually low in protein. The color of the kernels is used to determine sub-classes in wheat.
(d) Wheat of Other Classes

Wheats of the various classes are often used for specific purposes. Mixtures are not desired by the grain trade. Durum wheat is particularly undesirable in large quantities in the bread wheats.

II. Laboratory Instructions

1. Look over the special mounts for examples of the various forms of damage, and for color differences.

2. Obtain a sample of approximately 1000 grams of hard red spring wheat from the instructor.

3. Determine odors, treated, dockage, live weevils, garlic, and class on this sample.

4. Remove the dockage. Determine inseparable stones on the dockage-free sample.

5. Reduce the size of the sample thru the Boerner sampler to approximately 25 grams. Determine the exact weight. Determine smut balls on this part.

6. Reduce a portion of the dockage-free wheat to approximately 50 grams. Determine damage, and also foreign material on this portion. Make weights and determine percentages. (Wheat of special limitations is also determined on approximately 50 grams.)

7. The other sample of approximately 50 grams should be reduced to two approximate 25 gram samples. Color and texture should be determined on one part, and wheat of other classes on the other part. Weigh and determine percentages.

8. Fill in a form to show the various factors, i.e., damaged kernels, foreign material, wheat of other classes, and color and texture.

III. Questions to be Answered

1. What is foreign material? Why is it a grading factor in wheat?
2. What causes heat damage in wheat?
3. How can heat-damaged kernels be identified?
4. Why are heat-damaged kernels discriminated against so severely in the official standards?
5. Why are hard, vitreous kernels sought by the millers for bread wheats?
6. What grains or seeds are considered as "other grains" in the official standards for wheat?

References

Exercise 7

Protein Test for Wheat

(Optional)

I. Wheat Marketed on Protein Basis

High protein wheat (Call, et al.) sometimes commands a premium on the market when there is a scarcity of wheat of this character. It is usually 5-10 cents for each percent protein above 11.0 or 11.5 percent where other quality factors are satisfactory. Flour made from high protein wheat is in demand by commercial bakers because it makes a strong dough and a large number of loaves of bread from a given volume of flour. High protein wheat can usually be recognized by the hard vitreous texture and the deep red color of the grains. Soft, yellow, starchy kernels are almost invariably low in protein. Yellowberry wheat is objectionable from the market standpoint for that reason. High protein wheat may be produced when wheat of the Turkey type is grown provided soil and climatic conditions are favorable.

Climatic conditions greatly influence protein content. A long season with abundance of rain favors the development of soft, starchy kernels low in protein, while low rainfall, high temperatures, and a short ripening period favor the production of high protein wheat. The latter condition is found on the Great Plains. Seasonal variations may influence the protein content in the same variety. In Kansas, Call, et al., found the same variety of wheat from 10.4 pct. (1914) to 16.3 pct. (1918) Kerer et al. (1928) report a variation in Kanred 13.7 to 13.3 pct. over a 5-year period.

Soil conditions affect protein content. Sandy soils, especially those low in nitrogen, have a tendency to produce wheat low in protein. Many irrigated soils produce wheat low in protein, called Yellowberry wheat. Headon attributed this condition to an unfavorable ratio of nitrogen and phosphorus in the soil. Soils low in nitrogen produced soft wheats.

Protein is a collective term applied to all the substances found in the wheat kernel that contain nitrogen. The protein test by the Kjeldahl or modified methods is based upon the fact that 17.5 pce. of the protein in wheat is nitrogen. Protein tests carefully made on the same wheat agree rather closely. The gluten test, formerly used, is far less accurate.

Supplies necessary: (a) Chemical reagents necessary for the test can be made up as directed in Reference 1, p. 27. (b) Docketage sieves, (c) Burr mill, (d) Kjeldahl distillation flasks, (e) Electric heater.

1Note: This exercise may be given as a demonstration when equipment is unavailable for individual student use.
II. Preparation of Sample

1. Procurement of Sample.
   A representative sample is essential to the determination of the true value of a given lot of grain. A half-pound sample is usually sufficient.

2. To Clean Sample.
   Dockage should be removed before the sample is analyzed for protein. Dockage includes sand, dirt, weed seeds, chaff, straw, grass other than wheat, etc. It can be removed by appropriate sieves and devices.

3. Division of Sample.
   After a representative sample is taken, it is usually necessary to reduce its size considerably. Such can be accomplished by use of the Boerner sampler.

4. Grind Sample.
   Thirty to forty grams of wheat should be ground on a burr mill to such a degree of fineness that at least 60 percent of it will pass thru a No. 36 gritz-gauze sieve. The ground material should be immediately placed in a suitable air-tight container which should be large enough to allow the sample to be intimately mixed. The grinder should be thoroughly cleaned before each new sample of wheat is ground. Either disassemble the mill or pass a sufficient quantity of the new sample thru the burrs so that all traces of the previous sample will be entirely removed.

III. Method Recommended for Protein Test

1. Place one (1) gram of the sample in a digestion flask, together with approximately 7 to 10 grams of a mixture that contains by weight 8 grams of potassium sulphate, 4 grams of sodium sulphate, and one-half gram of copper sulphate. Add 20 to 25 cc. of sulfuric acid, thoroly mix the acid, salts, and sample together and digest for one hour.

2. Cool, dilute with 200 cc. of distilled water, add a few pieces of granulated zinc or pumice stone. Next, add sufficient sodium hydroxide solution to make the solution strongly alkaline, pouring the alkali down the side of the flask so that it does not immediately mix with the acid solution. Fifty cc. of the solution is usually enough.

3. Connect the flask with the condenser, mix the contents by shaking and distill until all the ammonia has passed over into a measured quantity of standard acid. The first 150 cc. of the distillate will generally contain all the ammonia. Titrate with the standard alkali.

4. Calculate, first into terms of nitrogen, later into protein by multiplication of the percentage nitrogen found by 5.7.

5. Reagents should be tested for absence of nitrogen by making a blank with sugar. The sugar partially reduces any nitrates present that otherwise might escape notice. Deduct any nitrogen found in the reagents from that found under the conditions of the test.
Laboratory Instructions

When the test is given by demonstrations, write up a detailed step-by-step account of the test.

V. Questions to be Answered

1. Why is the old gluten test unreliable?
2. How does climate affect the protein content of wheat? Soil?
3. Why are protein tests important at the present time?
4. Discuss bushel weight as an indicator of protein content in wheat.
5. What can the farmer do to increase the protein content in wheat?
6. How can wheat be estimated for protein content by sight?

Do these characteristics always hold? Why?

References

Exercise 3

Grading Wheat

I. Wheat Classes

Under the grain standards, "Wheat shall be any grain which, before the removal of dockage, consists of 50 percent or more of wheat and not more than 10 percent of other grains for which standards have been established—and which, after the removal of dockage, contains not more than 50 percent of broken kernels of grain of any size. The term wheat in these standards shall not include emmer, spelt, einkorn, Polish wheat and Poulard wheats."

The Federal grain standards provide for 7 classes of wheat, namely, Class I, Hard Red Spring Wheat; Class II, Durum Wheat; Class III, Red Durum Wheat; Class IV, Hard Red Winter Wheat; Class V, Soft Red Winter Wheat; Class VI, White Wheat; and class VII, Mixed Wheat.

Hard Red Spring wheat will be used as an example for grading wheat. The grade chart is also given for Hard Red Winter Wheat. Grades for the other classes are found in the Handbook of Official Grain Standards.

II. Grade Requirements for Hard Red Spring Wheat (Class I)

This class shall include all varieties of hard red spring wheat, and may include not more than 10 percent of wheats of other classes. This class shall be divided into three subclasses, as follows:

Subclass (A) Dark Northern Spring: This subclass shall include wheat of the class Hard Red Spring Wheat consisting of 75 percent or more of dark, hard, and vitreous kernels. This subclass shall not include more than 10 percent of wheat of the variety Rumpback.

Subclass (B) Northern Spring: This subclass shall include wheat of the class Hard Red Spring Wheat consisting of more than 25 percent but less than 75 percent of dark, hard, and vitreous kernels. This subclass shall not include more than 10 percent of wheat of the variety Rumpback.

Subclass (C) Red Spring: This subclass shall include wheat of the class Hard Red Spring Wheat consisting of not more than 25 percent of dark, hard, and vitreous kernels. This subclass shall also include wheat of the class Hard Red Spring Wheat consisting of more than 10 percent of the variety Rumpback.
Class I.—Hard Red Spring Wheat

Grade Requirements for (a) Dark Northern Spring, (b) Northern Spring, (c) Red Spring

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum Test Wt. per Bu. (Lbs)</th>
<th>Damaged Kernels (Wheat and other grains)</th>
<th>Foreign Material</th>
<th>Wheats of Other Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Damaged</td>
<td>Total Matter except other grains</td>
<td>Total Durum and/or Red Durum</td>
<td></td>
</tr>
<tr>
<td>1 Heavy</td>
<td>60</td>
<td>2</td>
<td>.1</td>
<td>0.5</td>
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<tr>
<td>1</td>
<td>58</td>
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<td>.1</td>
<td>0.5</td>
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<td>5</td>
<td>50</td>
<td>15</td>
<td>3.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Sample grade shall include wheat of the subclass Dark Northern Spring, or Northern Spring, or Red Spring, which does not come within the requirements of any of the grades from No. 1 Heavy to No. 5, inclusive; or which contains more than 15 percent of moisture; or which contains inseparable stones and/or cinders; or which is dusty, or sour, or heating, or hot; or which has any commercially objectionable foreign odor except of smut or garlic; or which contains a quantity of smut so great that any one or more of the grade requirements cannot be applied accurately; or which is otherwise of distinctly low quality.

1 Applies to each of the subclasses Dark Northern Spring, Northern Spring, and Red Spring.

2 Wheat of this class that contains more than 10 percent of broken kernels of grain that will pass thru a 20-gauge metal sieve with slotted perforations 0.064 inch wide by 3/8 inch long shall not be graded higher than No. 4.

III. Procedure for Grade Determination

1. Obtain a sample of hard red spring wheat and divide it by the Boerner Sampler so as to have approximately 1,000 grams.
2. Smell the sample for objectionable odors, and examine it for wild onions or garlic, live weevils or other insects injurious to stored grain, and for stones, cinders, etc.
3. Determine moisture (when it appears necessary)
4. Determine the class to which the wheat belongs. This is necessary before the proper riddles can be chosen for the Emerson Kicker.
5. Determine the dockage. Look over the large dockage material for stones and rye. The fine dockage should be examined for weevils and stones. Shake the fine dockage over the fine seed sieve (1/12-inch roundhole sieve) in all cases except where wild buckwheat, and chaff are in the original sample.
6. Using the sampler, cut the sample down to 250 grams and determine smut balls on this part when they are present. Reduce the other 250-gram sample down so as to have one sample of approximately 50 grams, and two samples of 25 grams each. (1) Pick the 50-gram sample for damage and also for foreign material. First, separate out the damaged kernels and determine the total percentage of the same. From the total damaged kernels, separate the heat damage and make a percentage determination based on the total sample. Second pick the same sample (or another 50-gram sample) for foreign material and make a percentage determination. Divide this foreign material into other grains, and other matter, and state the percentage of the latter based on the total sample. (2) From one of the 25-gram samples, separate the wheat of other classes and determine the percentage. Determine the percentage of durum and/or red durum which has been separated with the wheats of other
classes. (3) Separate the dark, hard, and vitreous kernels from the other 25-gram sample and determine the subclass according to the relative proportion by weight.

7. Record the results on a blank similar to the one at the end of this exercise. Determine the grade from the official standards. The lowest grading factor determines the grade. Always indicate the subclass along with the grade.

IV. Grade requirements for Hard Red Winter Wheat (Class IV)

This class shall include all varieties of Hard Red Winter Wheat, and may include not more than 10 percent of wheats of other classes. This class shall be divided into three subclasses, as follows:

Subclass (A) Dark Hard Winter.—This subclass shall include wheats of the class Hard Red Winter Wheat consisting of 75 percent or more of dark, hard, and vitreous kernels.

Subclass (B) Hard Winter.—This subclass shall include wheats of the class Hard Red Winter Wheat consisting of more than 25 percent but less than 75 percent of dark, hard, and vitreous kernels.

Subclass (C) Yellow Hard Winter.—This subclass shall include wheats of the class Hard Red Winter Wheat consisting of not more than 25 percent of dark, hard, and vitreous kernels.

Class IV—Hard Red Winter

Grade requirements for (a) Dark Hard Winter, (b) Hard Winter, (c) Yellow Hard Winter

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum test weight per bushel</th>
<th>Damaged kernels (wheat and other grains)</th>
<th>Foreign material</th>
<th>Thresh of other classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Los.</td>
<td>Total</td>
<td>Heat damaged</td>
<td>Total</td>
</tr>
<tr>
<td>1</td>
<td>60</td>
<td>2</td>
<td>0.1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>58</td>
<td>4</td>
<td>0.2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>56</td>
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<td>0.5</td>
<td>3</td>
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<tr>
<td>4</td>
<td>54</td>
<td>10</td>
<td>1.0</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>51</td>
<td>15</td>
<td>3.0</td>
<td>7</td>
</tr>
</tbody>
</table>

Sample grade

Sample grade shall include wheat of the subclass Dark Hard Winter, or Hard Winter, or Yellow Hard Winter, which does not come within the requirements of any of the grades from No. 1 to No. 5, inclusive, or which contains more than 15.5 percent of moisture; or which contains inseparable stones and/or cinders; or which is musty, or sour, or heating, or hot; or which has any commercially objectionable foreign odor except of smut or garlic; or which contains a quantity of smut so great that any one or more of the grade requirements cannot be applied accurately; or which is otherwise of distinctly low quality.

Wheat of this class that contains more than 10 percent of broken kernels of grain that will pass through a 20-mesh metal sieve with slotted perforations 0.064 inch wide by 3/8 inch long shall not be graded higher than No. 4.
V. Special Grades for Wheat

Special grade designations are added to and made a part of the grade designation to indicate qualities that cannot be expressed by the numerical grades alone. These are as follows:

1. Tough Wheat: Tough wheat shall be (a) wheat of any of the classes of Hard Red Winter Wheat, Soft Red Winter Wheat, or White Wheat, or of the class Mixed Wheat in which wheat of any one of the classes Hard Red Winter Wheat, or Soft Red Winter Wheat, or White Wheat, predominates, which contains more than 14 percent but not more than 15.5 percent of moisture, and (b) wheat of any of the classes Hard Red Spring Wheat, or Durum Wheat, or Red Durum Wheat, or of the class Mixed Wheat in which wheat of any one of the classes Hard Red Spring Wheat, or Durum Wheat, or Red Durum Wheat, predominates, which contains more than 14.5 percent but not more than 16 percent of moisture. Tough wheat shall be graded and designated according to the grade requirements of the standards applicable to such wheat if it were not tough, and there shall be added to, and made a part of, the grade designation, the word "Tough".

2. Smutty Wheat: Smutty wheat shall be wheat which has an unmistakable odor of smut, or which contains balls, portions of balls, or spores of smut in excess of a quantity equal to 14 balls of average size in 250 grams of wheat.

Smutty wheat shall be graded and designated according to the method described in paragraph (a) or paragraph (b) of this section.

(a) Smut dockage.—Before the determination of smut dockage as provided in this paragraph, the wheat shall be graded and designated according to the grade requirements of the standards applicable to such wheat if it were not smutty. The smut shall be removed by scouring and the loss in weight of the wheat caused by the removal of the smut shall be calculated in terms of percentage based on the total weight of the grain when free from dockage. The percentage so calculated shall be stated in terms of half percent, whole percent, or whole and half percent, as the case may be. A fraction of a half percent shall be disregarded. The percentage of the smut dockage, so calculated and stated, shall be added to the grade designation, preceding the statement of dockage, if any.

(b) "Light smutty" and "smutty".—Smutty wheat shall be graded and designated according to the grade requirements of the standards applicable to such wheat if it were not smutty; and

(1) In the case of smutty wheat which has an unmistakable odor of smut, or which contains balls, portions of balls, or spores of smut in excess of a quantity equal to 14 balls but not in excess of a quantity equal to 30 balls of average size in 250 grams of wheat, there shall be added to, and made a part of, the grade designation, the words "Light smutty"; and

(2) In the case of smutty wheat which contains balls, portions of balls, or spores of smut in excess of a quantity equal to 30 balls of average size in 250 grams of wheat, there shall be added to and made a part of the grade designation, the word "Smutty".

3. Garlicky Wheat: Garlicky wheat shall be wheat which contains two or more green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets in 1,000 grams of wheat. Garlicky wheat shall be graded and designated according to the grade requirements of the standards applicable to such wheat if it were not garlicky; and

(1) In the case of garlicky wheat which contains two or more but not more than six green garlic bulblets, or an equivalent quantity of dry or
partly dry bulblets, in 1,000 grams of wheat, there shall be added to, and
made a part of, the grade designation, the words "Light Garlicy"; and
(2) in the case of garlicy wheat which contains more than six green
garlicy bulblets, or an equivalent quantity of dry or partly dry bulblets,
in 1,000 grams of wheat, there shall be added to, and made a part of, the
grade designation, the word "Garlicy".

4. **Weevily Wheat**: Weevily wheat shall be wheat which is infested with live
weevils or other insects injurious to stored grain. Weevily wheat shall
be graded and designated according to the grade requirements of the
standards applicable to such wheat if it were not weevily, and there shall
be added to, and made a part of, the grade designation, the word "Weevily".

5. **Ergoty Wheat**: Ergoty wheat shall be wheat which contains ergot in excess
of 0.3 percent. Ergoty wheat shall be graded and designated according to
the grade requirements of the standards applicable to such wheat if it were
not ergoty, and there shall be added to, and made a part of, the grade
designation, the word "Ergoty".

8. **Treated Wheat**: Treated wheat shall be wheat which has been secured, lined,
washed, sulphured, or treated in such a manner that its true quality is
not reflected by either the numerical grade or the sample grade designation
alone. Treated wheat shall be graded and designated according to the
grade requirements of the standards applicable to such wheat if it were not
treated, and there shall be added to, and made a part of, the grade
designation, a statement indicating the kind of treatment.

VI. **Definitions and Terms**

The following definitions apply to wheat for the application of the official
grain standards:

1. **Basis of Grade Determinations**: Each determination of moisture, tempera-
ture, odor, garlic, and live weevils, or other insects injurious to stored grain,
shall be upon the basis of the grain as a whole. All other determinations
shall be upon the basis of the grain when free from damage.

2. **Percentages**: Percentages, except in the case of moisture, shall be per-
centages ascertained by weight.

3. **Percentage of Moisture**: Percentage of moisture shall be that ascertained
by the air oven and the method of use thereof described in Service and
Regulatory Announcements No. 147 of the Bureau of Agricultural Economics
of the United States Department of Agriculture, or ascertained by any
device and method which give equivalent results in the determination of
moisture.

4. **Test Weight per Bushel**: Test weight per bushel shall be the weight per
Winchester bushel as determined by the testing apparatus and the method of
use thereof described in Bulletin No. 1065, dated May 10, 1932, issued by
the United States Department of Agriculture, or as determined by any device
and method which give equivalent results in the determination of tests
weight per bushel.

5. **Foreign Material**: Foreign material shall include all matter other than wheat
which is not separated from the wheat in the proper determination of do-\nchoke, except that smut balls shall not be considered as foreign materials.

6. **Other Grains**: Other grains shall include rye, oats, corn, grain sorghums,
barley, hull-less barley, flaxseed, amaran, spelt, einkorn, Polish wheat,
Poulard wheat, cultivated buckwheat, and soybeans.
7. **Damaged Kernels:** Damaged kernels shall be kernels and pieces of kernels of wheat and other grains which are heat damaged, sprouted, frosted, badly ground-damaged, badly weather-damaged, or otherwise materially damaged.

8. **Heat Damaged Kernels:** Heat damaged kernels shall be kernels and pieces of kernels of wheat and other grains which have been materially discolored and damaged by external heat or as a result of heating caused by fermentation.

### III. Laboratory Instructions

1. Grade a sample of Hard Red Spring Wheat. Record the results on a form similar to the one at the end of this exercise.

2. Grade a sample each of 2 other classes of wheat.

### IV. Questions to be Answered

1. What is wheat according to the official standards?
2. How do the sub-classes of hard red spring wheat differ?
3. How do hard red spring and hard red winter wheats differ in grade standards?
4. Why are Durum and Red Durum placed in different classes?
5. In what particulars do the grading factors for Durum wheat differ from those for hard red spring?
6. Name 5 important varieties of hard red spring, hard red winter, soft red winter, and white wheats.
7. How can hard red winter and hard red spring wheats be distinguished?
8. Are all club wheats white? How are they classified under the official Standards?
9. Where are the white wheats most widely grown?
10. What are the objections to mixed wheat?
11. What mixtures are most objectionable? Why?
12. How is mixed wheat graded?
13. Is dockage a grading factor in wheat? Why?
14. Under what conditions is wheat graded "Tough"? "Smutty"?
15. How do you determine whether or not wheat is "Culicly"?

### References

Outline I

<table>
<thead>
<tr>
<th>No. of Sample</th>
<th>Wt. per bush.</th>
<th>Moisture</th>
<th>Total Heat</th>
<th>Total Damage</th>
<th>Total Other</th>
<th>Total Other (wheat and other grains)</th>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wt. Fct. of Other grains</th>
<th>Foreign Material Matter except other grains</th>
<th>'Sheats of Other Classes</th>
<th>Durum and/or Red Durum</th>
<th>Sub-class</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
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Outline II

Dockage Determination

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<th>Number of sample</th>
<th>Kind</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subclasses should be designated as follows:

1. Dark Northern Spring -- D.N.S.
Exercise 9

Grading Shelled Corn

I. Classes for Corn

For the purposes of the official grain standards, corn shall be any grain which consists of 50 percent or more of shelled corn of the dent or flint varieties, and may contain not more than 10 percent of other grains for which standards have been established under the provisions of the United States Grain Standards Act.

Corn shall be divided into three classes, as follows: Class I, Yellow Corn; Class II, White Corn; and Class III, Mixed Corn.

(a) Yellow Corn (Class I)
This class shall include Yellow Corn, and may include not more than 5 percent of corn of other colors. A slight tinge of red on kernels of corn otherwise yellow shall not affect their classification as Yellow Corn.

(b) White Corn (Class II)
This class shall include White Corn, and may include not more than 2 percent of corn of other colors. A slight tinge of light straw color or of pink on kernels of corn otherwise white shall not affect their classification as White Corn.

(c) Mixed Corn (Class III)
This class shall consist of corn of various colors that does not meet the color requirements for either of the classes Yellow Corn or White Corn. White-capped yellow kernels shall be classified as Mixed Corn.

Grades.—Corn shall be graded and designated according to the respective grade requirements of the numerical grades and Sample grade of its appropriate class, and according to the special grades when applicable.

II. Grade Requirements

Grade requirements for Yellow Corn, White Corn, and Mixed Corn

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum test weight per bushel</th>
<th>Moisture Cracked and foreign material</th>
<th>Maximum limits of</th>
<th>Damage kernels</th>
<th>Heat damaged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pounds</td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
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<tr>
<td>2----------</td>
<td>33</td>
<td>15.5</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>3----------</td>
<td>51</td>
<td>17.5</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>4----------</td>
<td>48</td>
<td>20.0</td>
<td>5</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>5----------</td>
<td>44</td>
<td>23.0</td>
<td>7</td>
<td>15</td>
<td>3.0</td>
</tr>
<tr>
<td>Sample grade</td>
<td></td>
<td>Sample grade shall include corn of the class Yellow Corn, or White Corn, or Mixed Corn, which does not come within the requirements of any of the grades from No. 1 to No. 5, inclusive; or which contains stones and/or cinders; or which is musty, or sour, or heating, or hot; or which has any commercially objectionable foreign odor; or which is otherwise of distinctly low quality.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
III. Cracked Kernels and Foreign Material

The method for the determination of "cracked corn and foreign material" with the Emerson kicker is as follows:

1. Use a representative portion of approximately 1000 grams of the original sample.

2. Regulate the opening in the feed hopper to 3/8-inch wide, or so the sample will pass thru in about 25 seconds.

3. Use the step-metal scalper riddle having 12/64-inch round-hole perforations. (Remove all other sieves).

4. All material passing thru the riddle, plus any matter other than corn removed by hand picking from the mechanically-cleaned corn, shall constitute the "cracked corn and foreign material" in the sample.

IV. Procedure for Grade Determination

1. Determine odors on the sample as a whole. (Usually about 2000 grams).

2. Reduce the sample thru the Boerner Sampler so as to have approximately 1000 grams of corn.¹

3. Examine the 1000-gram sample for live weevils, and determine numbers.

4. Take the test weight. (Use 1 1/8 quarts or sufficient corn to overflow the kettle.)

5. Make a moisture determination.²

6. Weigh the sample.

7. Determine cracked corn and foreign material, either with (1) the Emerson kicker, or (2) with a No. 12 hand (scalper) sieve. Compute the percentage on the total sample. (Examine the cracked kernels and foreign material for live weevils also).

8. After the removal of the cracked corn and foreign material, reduce the sample to two approximately 250-gram samples. (1) Pick one for color. (2) Pick the other for damaged kernels. Such kernels are caused by molds, rots, worm cuts, heat, etc. The blue mold is the worst form of damage. Molds must be apparent before the kernel can be considered damaged. Determine percent total damaged kernels. The heat-damaged kernels should be picked out of the total damaged kernels, weighed, and the percentage determined on the sample as a whole.

9. Refer to the official standards to determine the class and grade.

¹Note: For a sample already about 1000 grams in size, merely run it thru the sampler to mix it. Determine steps No. 1, 2, and 3, on this part.

²Moisture can be determined either on this part or on the referee sample.
V. Special Grades for Corn

1. Flint Corn:-- Flint corn shall be corn of any class which consists of more than 25 percent of flint corn. Flint corn shall be graded and designated according to the grade requirements of the standards applicable to such corn if it were not flint corn, and the word "Flint" shall be added to, and made a part of, the grade designation, immediately following the word Yellow, or White, or Mixed, as the case may be.

2. Weevily Corn:-- Weevily corn shall be corn that is infested with live weevils or other insects injurious to stored grain. Weevily corn shall be graded and designated according to the grade requirements of the standards applicable to such corn if it were not weevily, and there shall be added to, and made a part of, the grade designation, the word "Weevily."

VI. Definitions

1. Basis of Grade Determinations.-- Each determination of class, variety, damage, and heat damage, shall be upon the basis of the grain after the removal of the cracked corn and foreign material. All other determinations shall be upon the basis of the grain as a whole.

2. Percentages.--Percentages, except in the case of moisture, shall be percentages ascertained by weight.

3. Percentage of moisture.--Percentage of moisture shall be that ascertained by the water oven and the method of use thereof described in Service and Regulatory Announcements No. 147 of the Bureau of Agricultural Economics of the United States Department of Agriculture, or ascertained by any device and method which give equivalent results in the determination of moisture.

4. Test weight per bushel.-- Test weight per bushel shall be the weight per Winchester bushel as determined by the testing apparatus and the method of use thereof described in Bulletin No. 1065, dated May 18, 1922, issued by the United States Department of Agriculture, or as determined by any device and method which give equivalent results in the determination of test weight per bushel.

5. Cracked corn and foreign material.--Cracked corn and foreign material shall include kernels and pieces of kernels of corn and all matter other than corn which will pass through a No. 12 sieve, and all matter other than corn remaining on such sieve after screening.

6. No. 12 sieve.-- A metal sieve perforated with round holes \( \frac{3}{64} \) inch in diameter.

7. Other Grains.--Other grains shall include wheat, rye, oats, grain sorghums, barley, hull-less barley, flaxseed, emmer, spelt, einkorn, Polish wheat, pearl barley, cultivated buckwheat, sweet corn, pop corn, and soybeans.
8. Damaged Kernels.— Damaged kernels shall be kernels and pieces of kernels of corn which are heat damaged, sprouted, frosted, badly ground damaged, badly weather damaged, or otherwise materially damaged.

9. Heat-damaged Kernels.— Heat-damaged kernels shall be kernels and pieces of kernels of corn which have been materially discolored and damaged by external heat or as a result of heating caused by fermentation.

VII. Bushel Weight and Maturity

A relationship has been found between bushel weight and maturity in corn. Corn harvested after maturity in the field underwent little change in bushel weight. Mature corn had a test weight well over 54 lbs., the minimum requirement for U.S. No. 1 corn. Maturity of Golden Glow corn in Colorado at the time of harvest should be suspected when the bushel weight falls below 54 lbs.

VIII. Laboratory Instructions

1. Secure a sample of shelled corn from the instructor and grade it.
2. Record the results.

IX. Questions to be Answered

1. Name and define the classes for corn.
2. How do you determine dockage in corn?
3. Are cracked kernels of corn classed as damaged? Why?
4. Why are white and yellow corns placed in different classes?
5. What relationship exists between bushel weight and maturity in corn?

References

Exercise 10
Grading Barley

1. Barley Classes

Barley shall be any grain which, before the removal of dockage, consists of 50 percent or more of barley, and may contain not more than 25 percent of other grains for which standards have been established (wheat, corn, oats, rye, grain sorghums, and flaxseed). The term "barley" as used in these standards shall not include hull-less barley.

The Federal barley standards provide for 4 classes based on color and on its area of production. These are as follows: Class I, Barley; Class II, Black Barley; Class III, Western Barley; and Class IV, Mixed Barley. Class I Barley will be considered in this exercise.

There are 3 special grades for barley applicable to all classes. These are Two-rowed, Tough, Blighted, Smutty, Garlicky, Weevily, Ergoty, and Bleached. There are 3 special grades applicable only to Class III Western Barley, namely, Test weight, Bright, and Stained.

Class I Barley includes all white (glumes) barley grown east of the Rocky Mountains, and may include not more than 10 percent of barley of other classes. This class is divided into two subclasses, viz., Subclass (A) Malting Barley, and Subclass (B) Barley.

The subclass Malting Barley has special limitations for admixtures of certain types as well as for barley varieties which are undesirable in barley intended for the malting process. All subclass specifications for Malting Barley are based on the sample after the removal of dockage. The Malting Barley designation also is applied only to numerical grades 1 to 3, inclusive.

Grade Chart for Class I Barley

The numerical grade specifications for test weight, sound barley, heat-damaged kernels, foreign material, broken kernels, black barley, and blight-damaged barley are given below.
Grade requirements for subclass (a) Malting Barley and subclass (b) Barley, of the class Barley, and for the class Black Barley.

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum limits of</th>
<th>Maximum limits of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test weight per bushel</td>
<td>Sound barley¹</td>
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<tr>
<td>13--------</td>
<td>47</td>
<td>95</td>
</tr>
<tr>
<td>23--------</td>
<td>46</td>
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<td>80</td>
</tr>
<tr>
<td>5 --------</td>
<td>35</td>
<td>70</td>
</tr>
</tbody>
</table>

Sample grade

Sample grade shall include barley of the subclass Barley, or of the class Black Barley, which does not come within the grade requirements of any of the grades from No. 1 to No. 5, inclusive; or which contains more than 16 percent of moisture; or which contains inseparable stones and/or cinders; or which is musty, or sour, or heating, or hot; or which has any commercially objectionable foreign odor except of smut or garlic; or which contains a quantity of smut so great that any one or more of the grade requirements cannot be applied accurately; or which otherwise is of distinctly low quality.

¹Any barley in grade No. 1 that does not come within the provisions of the special grade Blighted, may contain not more than 2 percent of blight-damaged barley; and barley in any grade from No. 2 to Sample grade, inclusive, that does not come within the provisions of the special grade Blighted, may contain not more than 4 percent of blight-damaged barley. Any barley containing more than 4 percent of blight-damaged barley shall be graded No. 1, No. 2, No. 3, No. 4, No. 5, or Sample grade, Blighted, as the case may be, as provided in the specifications for Blighted barley.

²These specifications do not apply to the class Black Barley.

³See special requirements for subclass (A) Malting Barley.

⁴Barley that is badly stained or materially weathered, shall not be graded higher than No. 4.
III. Preliminary Examination

The first step in the grading of barley is to determine whether the original sample consists of "50 percent or more of barley," and whether it contains "not more than 25 percent of other grains." These determinations are usually made by observation.

The odor and temperature of the grain and the absence or presence of live weevils should be determined when the sample is first taken and before any cleaning or sieving determinations are made. Musty or sour barley is graded Sample Grade as well as barley which has an odor of hides, oil, fertilizer, or similar objectionable odors. Barley that is heating or hot is also graded Sample Grade. Barley is considered infested with live weevils or other insects injurious to stored grain when a representative sample of approximately 100 grams contains (1) 2 or more live weevils, or (2) one live weevil and 10 or more other insects injurious to stored grain, or (3) 25 or more other insects injurious to stored grain. These determinations are made on the grain before the removal of dockage.

IV. Determination of Dockage in Barley

Dockage in barley includes the coarse foreign material such as straws, corn, large soybeans, unthreshed barley heads, as well as fine material such as weed seeds, dirt, etc. Dockage can be removed by the Emerson Kicker and supplemental sieve.

1. Method with Emerson Kicker: Use a representative portion of the original sample of sufficient quantity to provide at least 1-1/2 quarts of dockage-free grain for the test weight determination. Use the Emerson Kicker equipped with the stop-metal barley scalper riddle. Place the sieve with 5/34-inch (diameter of inscribed circle) equilateral triangular perforations in the bottom of the machine with the wide end of the perforations facing the feed end of the machine.

2. Reclaiming Barley: In case the material that passes over the riddle contains barley, such barley shall be picked out and returned to the cleaned sample. In case the material that passes thru the machine sieve contains barley, such barley shall be reclaimed over the hand sieve with 5/34-inch (diameter of inscribed circle) equilateral triangular perforations. In this re-screening process place not more than 50 grams of the material on the sieve at the upper edge; then with the sieve held at an angle of 10 to 20 degrees, work the material down over the sieve by a gentle side-sieving motion. Repeat the operation on additional 50-gram portions until all the material has been re-screened. The barley and other material on top of the hand sieve shall be returned to the cleaned sample, and all material passing thru the hand sieve shall be considered as dockage.

3. Dockage Calculation: The dockage will then consist of the material other than barley that passes over the riddle, the dockage material that sticks in the riddle, and the material that passes either thru the machine sieve without hand sieving, or thru the hand sieve when used as a reclaiming sieve. The quantity of dockage shall be calculated in terms of percentage based on the total weight of the grain with dockage included. The percentage of dockage, so calculated, when equal to 1 percent or more shall be stated in terms of whole percent, and when less than 1 percent shall not be stated. The word "dockage," together with the percentage thereof, shall be added to the grade designation.
V. Determinations on Dockage-Free Sample

The remainder of the determinations are made on the dockage-free sample.

1. Moisture Determination: Class I Barley is designated as "Tough" Barley when it contains more than 14.5 percent but not more than 16.0 percent moisture. Tough Barley is not excluded from the Malting Subclass. When the moisture content exceeds 16.0 percent, the barley is graded Sample Grade and is excluded from Malting Barley. The moisture determination is made by either the Tag-Heppenstall Moisture Meter or the Brown-Duvel moisture Tester.

2. Test Weight: Use approximately 1-1/8 quarts of grain after the dockage has been removed for the test weight determination. The weight is recorded as whole and half pounds. Barley must test at least 45 pounds (No. 3) to the bushel to grade Malting Barley.

3. Sound Barley: Smut masses, adobe, and cinders are determined not less than 500 grams. The sample is then reduced to not less than 30 grams for the remainder of the determinations. The percentage of sound barley in a sample is 100 percent less the sum of the percentages of other grains, wild oats, foreign material, and all damaged barley. Sound barley includes pieces of sound kernels of barley that remain in the sample after the removal of dockage. The determination of sound barley is made on a 30-gram sample of the dockage-free barley. This same portion may be used for the determination of foreign material, broken kernels, black barley, and blight-damaged barley, all of which are numerical grading factors.

The experienced grader will also use this portion to determine the malting subclass limitations of unsuitable malting types, skinned and broken kernels, and damaged barley.

4. Grade Designation: The grade designation for Subclass (A) Barley can be given at this point. e.g. No. 1 Barley.

VI. Malting Subclass Specifications

For barley of Class I, it is necessary to make supplemental tests to determine whether it can be graded in the premium subclass "Malting Barley".

1. Subclass Malting Barley: This subclass shall include 6-rowed barley of the class Barley (Class I) which meets the requirements of grades No. 1 to 3, inclusive, which, after the removal of dockage, contains not more than 5 percent of 2-rowed and/or other types of varieties of barley of unsuitable malting type such as Trebi and Black; which contains not more than 15 percent of barley and other matter that will pass thru a 20 gauge metal sieve with slotted perforations 0.076-inch wide and 0.75-inch long; which contains not more than 5 percent of skinned and/or broken kernels; which contains not more than 4 percent of damaged barley; and shall not include bleached barley. Barley of this subclass shall contain 75 percent or more of mellow barley kernels which kernels are not, en masse, semi-steely.

2. "Sizing" to Determine Malting Barley: The barley sizing determination shall be made on approximately 1-1/8 quarts of dockage-free barley. Place approximately one-third of the sample on a hand sieve (20-gauge metal sieve with slotted perforations 0.076-inch wide and 0.75 inch long) and sieve the barley as follows: Hold the sieve in both hands directly in front of the body
with elbows close to the sides. Hold the sieve level and so that the grain moves lengthwise of the slots. In a steady sieving motion move the sieve from right to left approximately 10 inches, and return left to right. Repeat the operation 30 times. Continue the operation on similar sized portions of the sample, cleaning the sieve and emptying the bottom pan after each portion is sieved. The barley that remains in the slots should be returned to the portion of the sample which remains on top of the sieve. All barley and other material which passes through the slotted perforations shall be weighed and the percentage thereof computed. Then the thin barley and foreign material that pass through the sieve are not in excess of 15 percent, the barley is classified as Malting Barley in so far as this determination applies.

5. **Testing for Mellow Barley Kernels:** The official grain standards for Class I Barley provide that Malting Barley shall contain 75 percent or more of mellow barley kernels which kernels are non massed and starchy. Mellowness has reference to stanchiness. To determine the percentage of mellow barley, a portion of approximately 50 grams of the dockage-free barley should be placed in a pearling machine and be subjected to the pearling process for about 3 minutes. The pearled barley is then freed from dust and hulls by sieving, after which the pearled kernels are weighed. All of the white and grey colored kernels that are 10 or more percent starchy in texture are classified as mellow kernels. All pearled kernels that range in color from a distinct tinge to a pronounced shade of green or blue and which appear to be 50 percent or more starchy in texture are also classified as mellow kernels. On the basis of the weight of the pearled kernels, the percentage of mellow barley is computed.

4. **Skinned and Broken Barley:** The official standards for barley provide a 5 percent limit of skinned and broken kernels in the grades for Malting Barley, but more lenient maximum limits for broken kernels only in the subclass (A) Barley and other classes of barley. A skinned kernel of barley is any kernel that has approximately one-third of the hull removed, or which has the germ and exposed in whole or in part. A broken kernel of barley is one that is cracked or fractured, regardless of the extent or size of the pieces. Not less than 50 grams of dockage-free barley is used for making this determination. The skinned and broken kernels (separated by hand) are weighed and the percentage computed.

5. **Damaged Barley:** Damaged barley consists of kernels and pieces of kernels remaining after the removal of dockage which are damaged or materially discolored by blight and/or mold, or which are hard damaged, sprouted, frosted, badly ground damaged, badly weather damaged, or otherwise materially damaged. The official standards for barley provide a 4 percent limit of damaged barley in the grades for Malting Barley. A 30-gram portion of dockage-free barley is analyzed to determine the percentage of damaged barley.

6. **Unsuitable Malting Types:** The official standards allow a tolerance of 5 percent of 2-ruled, and/or other types or varieties of barley of unsuitable malting type such as Trebi and Black, in the subclass Malting Barley. To determine the percentage of such barley, approximately 50 grams of dockage-free barley are analyzed and the percentage computed.

7. **Other Subclass Requirements:** Malting Barley must meet the requirements of the numerical grades No. 1 to 2 inclusive. Bleached barley is excluded from the Malting subclass.
VII. Special Grades for Barley

1. **Two-rowed Barley:** Two-rowed barley shall consist of 2-rowed barley of the subclass barley of the class Barley, or of the class Western Barley, and may contain not more than 10 percent of barley of other varieties. Two-rowed barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not 2-rowed, and there shall be added to, and made a part of, the grade designation, preceding the name of the class, the word "Two-rowed".

2. **Tough Barley:** Tough barley shall be (a) barley of either of the classes Barley or Black Barley, or of the class Mixed Barley in which barley of either one of the classes Barley or Black Barley predominates, which contains more than 14.5 percent but not more than 16 percent of moisture, and (b) barley of the class Western Barley, or of the class Mixed Barley in which barley of the class Western Barley predominates, which contains more than 13.5 percent but not more than 15 percent moisture.

   Tough Barley should be graded and designated according to the grade requirements of the standards applicable to such barley if it were not tough, and there shall be added to, and made a part of, the grade designation, the word "Tough".

3. **Blighted Barley:** Blighted barley shall be all barley which contains more than 4 percent of barley damaged or materially discolored by blights and/or mold. Blighted barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not blighted, and there shall be added to, and made a part of, the grade designation, the word "Blighted".

4. **Smutty Barley:** Smutty barley shall be barley which has the kernels covered with smut spores, or which contains smut masses in excess of 0.2 percent. Smutty barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not smutty, and there shall be added to, and made a part of, the grade designation, the word "Smutty".

5. **Garlicky Barley:** Garlicky barley shall be barley which contains 3 or more green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets, in 500 grams of barley. Garlicky barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not garlicky, and there shall be added to, and made a part of, the grade designation, the word "Garlicky".

6. **Weevily Barley:** Weevily barley shall be barley which is infested with live weevils or other insects injurious to stored grain. Weevily barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not weevily, and there shall be added to, and made a part of, the grade designation, the word "Weevily".

7. **Ergoty Barley:** Ergoty barley shall be barley which contains ergot in excess of 0.3 percent. Ergoty barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not ergoty, and there shall be added to, and made a part of, the grade designation, the word "Ergoty".

8. **Bleached Barley:** Bleached barley shall be barley which, in whole or in part, has been treated by the use of sulphurous acid or any other
bleaching agent. Bleached barley shall be graded and designated according to the grade requirements of the standards applicable to such barley if it were not bleached, and there shall be added to, and made a part of, the grade designation the word "Bleached."

VII. Definitions

1. Basis of Grade Determinations. Each determination of dockage, temperature, ow, garlic, and live weevils or other insects injurious to stored grain shall be upon the basis of the grain as a whole. All other determinations shall be upon the basis of the grain when free from dockage.

2. Percentages. Percentages, except in the case of moisture, shall be percentages ascertained by weight.

3. Foreign Material. Foreign material shall include all matter other than barley, except other grains, wild oats, and smut masses, which is not separated from the barley in the proper determination of dockage.

4. Other Grains. Other grains shall include wheat, rye, oats, corn, grain sorghums, hull-less barley, flaxseed, emmer, spelt, einkorn, Polish wheat, soldier wheat, cultivated buckwheat, and soybeans.

5. Sound barley. Sound barley shall be kernels and pieces of kernels of barley remaining after the removal of dockage, which are not damaged or materially discolored by blight and/or mold, which are not heat damaged, sprouted, frosted, badly ground damaged, badly weather damaged, or otherwise materially damaged.

6. Heat-damaged kernels. Heat damaged kernels shall be kernels and pieces of kernels of barley, other grains, and wild oats, which have been materially discolored and damaged by external heat or as a result of heating caused by fermentation.

VIII. Laboratory Instructions

1. Procure a sample of barley from the instructor and determine the grade.

2. Grade one sample for Subclass (E) Malting Barley.

IX. Questions to be Answered

1. How does malting barley differ from ordinary barley?

2. Under what conditions does moisture influence the grade? How?

3. How is dockage determined in barley?

4. How is two-rowed barley graded?

5. How are semi-steely kernels determined in malting barley?

6. What is meant by barley "sizing"? When is it done? How?

References

Exercise II

Grading Oats

I. Standards for Oats

Oats are defined in the Federal grain standards as grain which consists of 80 percent or more of cultivated oats. Oats may contain not more than 10 percent of wild oats.

Oats shall be divided into five classes based on color as follows: Class I, White Oats; Class II, Red Oats; Class III, Gray Oats; Class IV, Black Oats; and Class V, Mixed Oats. For the purpose of this classification, the characteristics of each class, except Mixed Oats, shall be based on color characteristics; White Oats shall include yellow oats; and tinges of white, brown, or black, on the kernels of any red oats variety shall not affect their classification as red oats. Oats of any class except Mixed Oats may include not more than 10 percent of cultivated oats of other classes. Mixed Oats shall be any mixture of oats which does not meet the requirements for any one of the classes White Oats, Red Oats, Gray Oats, or Black Oats.

There are 10 special grades for oats which emphasize qualities or conditions that affect the value of the oats. These are Rough, Heavy, Extra Heavy, Bright, Thin, Bleached, Weevily, Smutty, Ergoty, and Garlicky.

Foreign material functions in 3 ways in the grading of oats, i.e., first as "foreign material", second as wild oats, and third as other grains.

This exercise deals only with oats. The standards for Feed Oats and Mixed Feed Oats can be found in the Official Handbook.
II. Grade Requirement for Oats

Oats

Grade requirements for the classes White Oats, Red Oats, Gray Oats, Black Oats, and Mixed Oats

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum limits of Test weight per bushel (Lbs.)</th>
<th>Minimum limits of Sound culti-vated kernels (oats, other grains, and wild oats) (Pct.)</th>
<th>Maximum limits of Heat-damaged kernels (oats, other grains, and wild oats) (Pct.)</th>
<th>Maximum limits of Foreign material (Pct.)</th>
<th>Maximum limits of Wild oats (Pct.)</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>27</td>
<td>90</td>
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<td>5</td>
</tr>
<tr>
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<td>24</td>
<td>80</td>
<td>3.0</td>
<td>5</td>
<td>10</td>
</tr>
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</table>

Sample grade—Sample grade shall include oats of any one of the classes White Oats, Red Oats, Gray Oats, Black Oats, or Mixed Oats, which do not come within the requirements of any of the grades from No. 1 to No. 4, inclusive; or which contain more than 16 percent of moisture; or which contain stones and/or cinders; or which are musty, or sour, or heating, or hot; or which have any commercially objectionable foreign odor except of smut or garlic; or which contain seeds of wild brome grasses of a character and in a quantity sufficient to cause the grain to be of low quality for feeding purposes; or which are otherwise of distinctly low quality.

1 The oats in grade No. 1 White Oats may contain not more than 5 percent of oats of other classes, of which not more than 3 percent may be black cultivated oats.

2 The oats in grade No. 2 White Oats may contain not more than 5 percent of black cultivated oats.

3 Oats that are slightly weathered shall not be graded higher than No. 3.

4 Oats that are badly stained or materially weathered shall not be graded higher than No. 4.

III. Sieving Method for Determination of Cereal Oats

The standards for oats provide that "Cereal Oats" shall be any oats, whether sized, clipped, or natural, which contain more than 20 percent of oats and/or other matter except fine seeds that will pass through a 20-gage metal sieve with slotted perforations 0.064 inch wide by 3/8 inch long.

This determination shall be made on the representative portion of the sample used in determining test weight (approximately 1 1/2 quarts). Place approximately one-third of such sample on a hand sieve having the specifications described above and sieve the oats in the following manner:
Hold the sieve in both hands directly in front of the body with elbows close to the sides. Hold the sieve level and so that the grain moves lengthwise of the slots. In a steady sieving motion, move the sieve from right to left approximately ten inches, and return left to right. Repeat the operation 20 times. Continue the operation on similar sized portions of the sample, cleaning the sieve and emptying the bottom pan after each portion is sieved. The oats remaining in the slots should be returned to the portion of the sample which remains on top of the sieve.

The material which passes through the sieve described above shall then be sieved over the "small buckwheat sieve" to remove the "fine seeds" which may be present.

All oats and other material which remain on top of the "small buckwheat sieve" shall be weighed and the percentage thereof computed on the basis of the weight of the original sample.

IV. Procedure for Grade Determination

1. Determine odor, general appearance, class, and bleached on the sample as a whole.
2. Make a moisture determination when that is considered necessary.
3. Reduce the sample to approximately 11/8 quarts. Live weevils should be determined on a sample of this size.
4. Determine the foreign material, i.e., shake over a metal sieve perforated with equilateral triangular perforations the inscribed circles of which are 5/64-inch in diameter. Suppose this turns out to be 0.50 percent.
5. Take the test weight.
6. Reduce the sample so as to obtain 2 samples, each of which is 30-50 grams in size. (Use the balance of the sample for sizing when it is necessary to make a determination for cereal oats).
7. Hand-pick one of the 30-50 gram samples for (1) class, and the other for (2) sound cultivated oats. Determine the percentage of sound cultivated oats (e.g., 90.5 percent) and subtract the percentage of foreign material obtained in paragraph 4, (e.g., 0.5 percent). Then, the sound cultivated oats are 90.5 - 0.5 = 90 percent.

V. Special Grades for Oats

1. Tough Oats: Tough oats shall be oats which contain more than 14.5 percent but not more than 16 percent of moisture. Tough oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not tough, and there shall be added to and made a part of, the grade designation, the word "Tough."

2. Heavy Oats: Heavy oats shall be oats which have a test weight per bushel of 35 pounds or more but less than 38 pounds. Heavy oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not heavy, and there shall be added to and made a part of, the grade designation, preceding the name of the class, the word "Heavy."
5. Extra Heavy Oats: Extra Heavy oats shall be oats which have a test weight per bushel of 38 pounds or more. Extra Heavy oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not extra heavy, and there shall be added to, and made a part of, the grade designation, preceding the name of the class the words "Extra Heavy".

4. Bright Oats: Bright oats shall be oats, except Bleached oats, that are of good natural color. Bright oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not bright, and there shall be added to, and made a part of the grade designation, preceding the name of the class, the word "Bright".

5. Cereal Oats: Cereal oats shall be any oats, whether sized, clipped, or natural, which contain more than 20 percent of oats and/or other matter except "fine seeds" that will pass through 20-gage metal sieve with slotted perforations 0.064 inch wide by 3/8 inch long. Cereal oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not "cereal" oats, and there shall be added to, and made a part of, the grade designation, the word "Cereal".

6. Bleached Oats: Bleached oats shall be oats which, in whole or in part, have been treated by the use of sulphurous acid or any other bleaching agent. Bleached oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not bleached, and there shall be added to, and made a part of, the grade designation, the word "Bleached".

7. Weevily Oats: Weevily oats shall be oats which are infested with live weevils or other insects injurious to stored grain. Weevily oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not weevily, and there shall be added to, and made part of, the grade designation, the word "Weevily".

8. Smutty Oats: Smutty oats shall be oats which have the kernels covered with smut spores, or which contain smut masses and/or smut balls in excess of 0.2 percent. Smutty oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not smutty, and there shall be added to, and made a part of, the grade designation the word "Smutty".

9. Ergoty Oats: Ergoty oats shall be oats which contain ergot in excess of 0.3 percent. Ergoty oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not ergoty, and there shall be added to and made a part of, the grade designation, the word "Ergoty".

10. Garlicky Oats: Garlicky oats shall be oats which contain 4 or more green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets, in 500 grams of oats. Garlicky oats shall be graded and designated according to the grade requirements of the standards applicable to such oats if they were not garlicky, and there shall be added to and made a part of, the grade designation, the word "Garlicky".
VI. Laboratory Instructions
1. From a sample of mixed oats, separate into wild and cultivated oats.
2. Grade a sample of oats.

VII. Questions to be Answered
1. How do "oats differ from "Feed Oats"? "Mixed Feed Oats"?
2. Distinguish between wild and cultivated oats.
3. Explain how to determine cereal oats.
4. Describe the special grades Tough, Heavy, and Extra Heavy Oats.

References
I. Grade Requirements for Rye

Rye shall be any grain which before the removal of dockage, consists of 50 percent or more of rye and not more than 10 percent of other grains for which standards have been established. Rye shall be graded and designated according to the respective grade requirements of the numerical grades and sample grade of these standards, and according to the special grades when applicable.

Standards for Rye

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum test wt. per bu.</th>
<th>Damaged kernels (rye and other grains)</th>
<th>Foreign matter other than wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lbs.</td>
<td>Total</td>
<td>Heat damaged</td>
</tr>
<tr>
<td>1</td>
<td>56</td>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>54</td>
<td>4</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>52</td>
<td>7</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>49</td>
<td>15</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Sample grade shall include rye which does not come within the requirements of any of the grades from No. 1 to No. 4, inclusive; or which contains more than 16 percent of moisture; or which contains inseparable stones and/or cinders; or which is musty, or sour, or heating, or hot; or which has any commercially objectionably foreign odor except of smut or garlic; or which contains a quantity of smut so great that any one or more of the grade requirements cannot be applied accurately; or otherwise of distinctly low quality.

II. Methods for the Determination of Dockage in Rye

The same procedure should be followed as for wheat, except that: (1) the No. 2 riddle always shall be used in the Emerson Kicker for rye-dockage determinations, (2) in case of rye containing wild buckwheat and other weed seeds of similar size and shape the large buckwheat sieve shall be used in the Emerson Kicker only when the rye (original sample) contains more than 0.5 percent of wild buckwheat, etc., and (3) in the case of rye containing chest and/or quack grass and/or other weed seeds of similar size and shape, no attempt shall be made to remove such chest, etc., by the use of chest sieve. In other words, chest, etc., after the removal of dockage, shall be considered as foreign material and the sample graded accordingly.

All threshed kernels of rye that are kicked over the riddle with the coarse dockage shall be picked out and put back in the cleaned sample.
III. Special Grades for Rye
(a) Tough Rye

Definition.--Tough rye shall be rye which contains more than 14 percent, but not more than 16 percent, of moisture.

Grades.--Tough rye shall be graded and designated according to the grade requirements of the standards applicable to such rye if it were not tough, and there shall be added to, and made a part of, the grade designation, the word "Tough."

(b) Smutty Rye

Definition.--Smutty rye shall be rye which has an unmistakable odor of smut, or which contains balls, portions of balls, or spores, of smut, in excess of a quantity equal to 14 balls of average size in 250 grams of rye.

Grades.--Smutty rye shall be graded and designated according to the grade requirements of the standards applicable to such rye if it were not smutty; and

(1) in the case of smutty rye which has an unmistakable odor of smut, or which contains balls, portions of balls, or spores, of smut, in excess of a quantity equal to 14 balls, but not in excess of a quantity equal to 30 balls of average size in 250 grams of rye, there shall be added to, and made a part of, the grade designation, the words "Light Smutty"; and

(2) in the case of smutty rye which contains balls, portions of balls, or spores, of smut, in excess of a quantity equal to 30 balls of average size in 250 grams of rye, there shall be added to, and made a part of, the grade designation, the word "Smutty."

(c) Garlicy Rye

Definition.--Garlicy rye shall be rye, which contains 2 or more green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets, in 1,000 grams of rye.

Grades.--Garlicy rye shall be graded and designated according to the grade requirements of the standards applicable to such rye if it were not garlicky; and

(1) in the case of garlicky rye which contains 2 or more but not more than 6 green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets, in 1,000 grams of rye, there shall be added to, and made a part of, the grade designation, the words "Light Garlicy"; and

(2) in the case of garlicky rye which contains more than 6 green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets, in 1,000 grams of rye, there shall be added to, and made a part of, the grade designation, the word "Garlicky."

(d) Weevily Rye

Definition.--Weevily rye shall be rye which is infested with live weevils or other insects injurious to stored grain.

Grades.--Weevily rye shall be graded and designated according to the grade requirements of the standards applicable to such rye if it were not weevily and there shall be added to, and made a part of, the grade designation, the word "Weevily."

(e) Ergoty Rye

Definition.--Ergoty rye shall be rye which contains ergot in excess of 0.3 percent.

Grades.--Ergoty rye shall be graded and designated according to the grade requirements of the standards applicable to such rye if it were not ergoty, and there shall be added to, and made a part of, the grade designation, the word "Ergoty."
IV. Definitions

1. Basis of grade determinations.—Each determination of dockage, temperature, odor, garlic, and live weevils or other insects injurious to stored grain, shall be upon the basis of the grain as a whole. All other determinations shall be upon the basis of the grain when free from dockage.

2. Percentages.—Percentages, except in the case of moisture, shall be percentages ascertained by weight.

3. Percentages of moisture.—Percentage of moisture shall be that ascertained by the air oven and the method of use thereof described in Service and Regu-

4. Test weight per bushel.—Test weight per bushel shall be the weight per Winchester bushel as determined by the testing apparatus and the method of use thereof described in Bulletin No. 1065, dated May 18, 1928, issued by the United States Department of Agriculture, or as determined by any device and method which give equivalent results in the determination of moisture.

5. Foreign material.—Foreign material shall include all matter other than rye, which is not separated from the rye in the proper determination of dockage, except that smut balls shall not be considered as foreign material.

6. Other grains.—Other grains shall include wheat, oats, corn, grain sorghums (barley, hull-less barley, flaxseed, emmer, spelt, einkorn, Polish wheat, poulard wheat, cultivated buckwheat, and soybeans."

7. Damaged kernels.—Damaged kernels shall be kernels and pieces of kernels of rye and other grains which are heat damaged, sprouted, frosted, badly ground damaged, badly weather damaged, or otherwise materially damaged.

8. Heat-damaged kernels.—Heat-damaged kernels shall be kernels and pieces of kernels of rye and other grains which have been materially discolored and damaged by external heat or as a result of heating caused by fermentation.

V. Laboratory Instructions

1. Carefully go over small samples of rye and wheat and notice the differences in kernel shape.

2. Secure a sample of rye from the instructor and grade it. Follow the procedure for wheat.

3. Record the grade on a blank similar to the one at the end of Exercise 35.

VI. Questions to be Answered

1. How can rye be distinguished from wheat?

2. How does the dockage determination in rye differ from that in wheat?

3. How is garlicky rye graded?

4. What is the definition of rye under the official grain standards?

References


Phillips, O.F. Use of Sieves and Cleaning Devices under the United States Grain Standards, Geo. Field Eco, Keno. No. 149, pp. 32. 1936
Exercise 13
Grading Grain Sorghums

I. Standards for Grain Sorghums
(a) Grain Sorghums
Grain sorghums shall be any grain thick, before the removal of dockage, consists of 50 percent or more of grain sorghums and not more than 10 percent of other grains for which standards have been established under the provisions of the United States Grain Standards Act, and which, after the removal of dockage and "cracked kernels, foreign material, and other grains", contains not more than 25 percent of nongrain sorghums.
(b) Classes
Grain sorghums shall be divided into five classes, as follows: Class I, White Grain Sorghums; Class II, Yellow Grain Sorghums; Class III, Red Grain Sorghums; Class IV, Brown Grain Sorghums; and Class V, Mixed Grain Sorghums.
(c) Grades
Grain sorghums shall be graded and designated according to the respective grade requirements of the numerical grades and Sample Grade of their appropriate class or subclass, and according to the special grades when applicable.

II. Classes and Sub-Classes
(a) White Grain Sorghums (Class I)
This class shall include all varieties of white grain sorghums, and may include not more than 10 percent of grain sorghums of other colors; colored spots upon kernels that are otherwise white shall not affect their classification as white. This class shall be divided into three subclasses, as follows:

Subclass (A) White Kafir.--This subclass shall include grain sorghums of the white kafir type, including kafir, and may include not more than 10 percent of other white grain sorghums, grain sorghums of other colors, or nongrain sorghums of other colors, singly or in any combination.

Subclass (B) White Durra.--This subclass shall include grain sorghums of the white durra type, and may include not more than 10 percent of other white grain sorghums, grain sorghums of other colors, or nongrain sorghums of other colors, singly or in any combination.

Subclass (C) White Grain Sorghums.--This subclass shall include all grain sorghums of the class White Grain Sorghums not coming within the classification for subclass (A) White Kafir or subclass (B) White Durra.

(b) Yellow Grain Sorghums (Class II)
This class shall include all varieties of yellow and salmon-pink grain sorghums, and may include not more than 10 percent of grain sorghums of other colors. This class shall be divided into two subclasses, as follows:

Subclass (A) Yellow Milo.--This subclass shall include grain sorghums of the yellow milo type, and may include not more than 10 percent of other yellow grain sorghums, grain sorghums of other colors, or nongrain sorghums of other colors, singly or in any combination.

Subclass (B) Yellow Grain Sorghums.--This subclass shall include all grain sorghums of the class Yellow Grain Sorghums not coming within the classification for subclass (A) Yellow Milo.

(c) Red Grain Sorghums (Class III)
This class shall include all varieties of red grain sorghums, and may include not more than 10 percent of grain sorghums of other colors. This class shall be divided into two subclasses, as follows:

Subclass (A) Red Kafir.--This subclass shall include grain sorghums of the red kafir type and may include not more than 10 percent of other red grain sorghums, grain sorghums of other colors, or nongrain sorghums of other colors, singly or in any combination.

1White Kafir and Yellow Milo are most frequently graded in Colorado.
Subclass (5) Red Grain Sorghums.—This subclass shall include all grain sorghums of the class Red Grain Sorghums not coming within the classification for subclass (a) Red Kafir.

III. Grade Requirements for Grain Sorghums

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum test wt. per bushel</th>
<th>Minimum limits of damaged kernels (grain sorghums, nongrain sorghums, and other grains)</th>
<th>Total cracked kernels, foreign material, and other grains</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Moisture</td>
<td>Total</td>
</tr>
<tr>
<td>1----------</td>
<td>55</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>2----------</td>
<td>53</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>3----------</td>
<td>51</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>4----------</td>
<td>49</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Sample grade shall include grain sorghums of any class or sub-class which do not come within the requirements of any of the grades from No. 1 to No. 4, inclusive; or which contain inseparable stones and/or cinders; or which are musty, or sour, or heating, or hot; or which are badly weathered; or which have any commercially objectionable foreign odor except of smut; or which are otherwise of distinctly low quality.

IV. Dockage

Dockage includes sand, dirt, finely broken kernels, weed seeds, and other foreign material, which can be removed readily from the grain sorghums by means of a metal sieve perforated with round holes $2\frac{1}{64}$ inch in diameter. The quantity of dockage shall be calculated in terms of percentage based on the total weight of the grain including the dockage.

Dockage shall be stated in terms of whole percent. A fraction of a percent shall be disregarded. The word "Dockage," together with the percentage thereof, shall be added to the grade designation.

V. Method for Dockage Determination

The method for the determination of "dockage," and of "cracked kernels, foreign material and other grains," in grain sorghums is as follows:

(a) Instructions for the Use of Emerson Kicker

Use a representative portion of approximately 1,000 grains of the original sample.

Regulate the opening in the food hopper so that the entire sample will pass through in approximately 50 seconds.

Use no riddle.

Use the sieve with the $5/64$-inch (diameter of inscribed circle) triangular perforations in the bottom of the machine with the wide end of the perforations facing the food end of the machine.
(b) **Dockage**
All material passing through the machine sieve shall then be placed on a hand sieve having 2/64-inch round-hole perforations. The material shall be sieved vigorously and all material passing through this hand sieve shall constitute dockage.

(c) "**Cracked Kernels, Foreign Material and Other Grains**"

The material remaining on top of the 2/64-inch round-hole hand sieve shall constitute the mechanically-removable "cracked kernels, foreign material and other grains."

To complete the determination for total "cracked kernels, foreign material and other grains", not less than 50 grams of grain shall be cut from the mechanically-cleaned grain by using the Bormer sampler. Analyze (hand pick) this portion for foreign material and other grains and compute the percentage thereof on the basis of the weight of this portion.

(d) **Computation Total Cracked Kernels, Foreign Material and Other Grains**

In computing the total "cracked kernels, foreign material and other grains", the percentage of all such material remaining on top of the grain sorghums dockage hand sieve shall be computed on the basis of the dockage-free sample. The percentage of foreign material and other grains removed by hand-picking a portion of the mechanically-cleaned sample, determined on the basis of the weight in grams of the portion used for the hand separation, must be multiplied by the fractional proportion of grain sorghums remaining after the removal of the mechanically-separated "cracked kernels, foreign material and other grains."

For example, in a given sample the mechanically-separated "cracked kernels, foreign material and other grains" accounts to 10 percent. Thus, the fractional proportion of grain sorghums remaining after the removal of the mechanically-separated "cracked kernels, foreign material and other grains" is 90 percent. The percentage of foreign material and other grains, found in hand-picking the 50-gram portion of mechanically-cleaned grain sorghums (for example, 4 percent – 50-gram base), should be multiplied by 90, which gives 3.6 percent of "cracked kernels, foreign material and other grains" on the basis of the dockage-free sample, and which should be added to the 10 percent of "cracked kernels, foreign material and other grains" obtained by mechanical separation, thus giving the total actual "cracked kernels, foreign material and other grains" for the entire dockage-free sample as 13.6 percent.

**Illustration:**

Original sample - 1,000 grams.
Dockage 50 grams, or 5 percent dockage.
Dockage-free sample - 950 grams.
Mechanically-separated "cracked kernels, foreign material and other grains" - 95 grams, or 10 percent of 950 grams.
Dockage-free sample less 10 percent is 90 percent.
50 grams analyzed gives 2 grams foreign material and other grains, or 4 percent (50-gram base).
4 percent multiplied by 90 equals 3.6 percent.
10 percent mechanically-separated "cracked kernels, foreign material and other grains" plus 3.6 percent hand-picked foreign material and other grains equals 13.6 percent total actual "cracked kernels, foreign material and other grains."
VI. Procedure for Grade Determination

1. Determine odor and general appearance on sample as a whole.
2. Reduce the sample to approximately 1,000 grams through the Boerner sampler. Foreign material and cracked kernels, sand, dirt, finely broken seeds, and live seeds are determined on this amount.
3. Make a moisture determination on the other part of the original sample (should that be necessary).
4. Take the test weight per bushel.
5. Shake the 1,000-gram sample over a 9/64-inch hand buckwheat sieve to remove cracked kernels and dockage.
6. Separate the dockage from the cracked kernels by use of the 2 1/2/64-inch round-hole sieve. Compute the percentages of both cracked kernels and dockage.
7. Reduce the dockage-free sample to 30 grams and hand-pick for: (1) class, (2) damage, and (3) foreign material.
8. Calculate all required percentages and determine the grade.

VII. Special Grades for Grain Sorghums
(a) Bright Grain Sorghums
   Definition.—Bright grain sorghums shall be grain sorghums, of any class or subclass, which have good, natural color.
   Grades.—Bright grain sorghums shall be graded and designated according to the grade requirements of the standards applicable to such grain sorghums if they were not bright, and there shall be added to, and made a part of, the grade designation, preceding the name of the class or subclass, the word "Bright."
(b) Discolored Grain Sorghums
   Definition.—Discolored grain sorghums shall be grain sorghums of any class or subclass which are discolored, but which are not badly weathered.
   Grades.—Discolored grain sorghums shall be graded and designated according to the grade requirements of the standards applicable to such grain sorghums if they were not discolored and there shall be added to, and made a part of, the grade designation, the word "Discolored."
(c) Weevily Grain Sorghums
   Definition.—Weevily grain sorghums shall be grain sorghums which are infested with live weevils or other insects injurious to stored grain.
   Grades.—Weevily grain sorghums shall be graded and designated according to the grade requirements of the standards applicable to such grain sorghums if they were not weevily, and there shall be added to, and made a part of, the grade designation, the word "Weevily."
(d) Smutty Grain Sorghums
   Definition.—Smutty grain sorghums shall be grain sorghums which have the kernels covered with smut spores, or which contain a quantity of smut masses in excess of a quantity equal to 10 masses in 50 grams of grain sorghums.
   Grades.—Smutty grain sorghums shall be graded and designated according to the grade requirements of the standards applicable to such grain sorghums if they were not smutty, and there shall be added to, and made a part of, the grade designation, the word "Smutty."

VIII. Definitions
1. Basis of Grade Determinations.—Each determination of "cracked kernels, foreign material, and other grains", shall be upon the basis of the grain when
free from dockage. Each determination of class, subclass, nongrain sorghums, damage, heat damage, and inseparable stones and/or cinders, shall be upon the basis of the grain when free from dockage and when free from that part of the "cracked kernels, foreign material, and other grains" which can be removed readily by the use of a metal sieve perforated with equilateral triangular perforations the inscribed circles of which are 5/64 inch in diameter. All other determinations shall be upon the basis of the grain as a whole.

2. Percentages.—Percentages, except in the case of moisture, shall be percentages ascertained by weight.

3. Percentages of moisture.—Percentages of moisture shall be that ascertained by the air oven and the method of use thereof described in Service and Regulatory Announcements No. 147 of the Bureau of Agricultural Economics of the United States Department of Agriculture, or ascertained by any device and method which give equivalent results in the determination of moisture.

4. Test Weight per Bushel.—Test weight per bushel shall be the weight per Winchester bushel as determined by the testing apparatus and the method of use thereof described in Bulletin No. 1055, dated May 18, 1922, issued by the United States Department of Agriculture or as determined by any device and method which give equivalent results in the determination of test weight per bushel.

5. Other Grains.—Other grains shall include wheat, rye, oats, corn, barley, hull-less barley, flaxseed, emmer, spelt, einkorn, Polish wheat, poulard wheat, cultivated buckwheat, and soybeans.

6. Nongrain Sorghums.—Nongrain sorghums shall include broomcorn, Sudan grass, Johnson grass, and cane seed.

7. Cracked Kernels, Foreign Material, and Other Grains.—Cracked kernels, foreign material, and other grains, shall include kernels and pieces of kernels of grain sorghums, and all other matter except dockage that will pass through a metal sieve perforated with equilateral triangular perforations the inscribed circles of which are 5/64 inch in diameter; also other grains and all other matter except grain sorghums and nongrain sorghums remaining on such sieve after screening.

8. Damaged Kernels.—Damaged kernels shall be kernels and pieces of kernels of grain sorghums, nongrain sorghums, and other grains which are heat damaged, sprouted, frosted, badly ground damaged, moldy, or otherwise materially damaged.

9. Heat-damaged Kernels.—Heat-damaged kernels shall be kernels and pieces of kernels of grain sorghums, nongrain sorghums, and other grains which have been materially discolored and damaged by external heat or as a result of heating caused by fermentation.

IX. Laboratory Instructions

1. Procure a sample of grain sorghum from the instructor and grade it.

2. Record the grade, together with sub-class, and turn it in.

X. Questions to be Answered

1. How would you distinguish white kafir from white burra?

2. How can yellow milo be identified?

3. How is "cracked kernels, foreign material, and other grains" computed?

4. What is included in "nongrain sorghums"?
References


Exercise 14

Grading Flaxseed

I. Standards for Flaxseed
   (a) Flaxseed
      Flaxseed shall be any grain which, before the removal of dockage, consists of 50 percent or more of flaxseed and not more than 20 percent of other grains for which standards have been established under the provisions of the United States Grain Standards Act.
   (b) Grades
      Flaxseed shall be graded and designated according to the respective grade requirements of the numerical grades and Sample grade of those standards.

II. Grade Requirements for Flaxseed

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Minimum test weight per bushel</th>
<th>Maximum limits of damaged flaxseed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-----------------</td>
<td>49 pounds---------------------</td>
<td>20 percent</td>
</tr>
<tr>
<td>2-----------------</td>
<td>47 pounds---------------------</td>
<td>30 percent</td>
</tr>
<tr>
<td>Sample grade-----</td>
<td>Sample grade shall include flaxseed which does not come within the requirements of either of the grades No. 1 or No. 2; or which contains fire-damaged flaxseed; or which contains more than 11 percent of moisture; or which is musty, or sour, or heating or hot; or which has any commercially objectionable foreign odor; or which is otherwise of distinctly low quality.</td>
<td></td>
</tr>
</tbody>
</table>

III. Dockage

Dockage shall include all matter other than flaxseed which is contained in the lot of grain as a whole; also undeveloped, shriveled, and small pieces of flaxseed removed with the dockage and which cannot be recovered by properly rescreening or reclining. The quantity of dockage shall be calculated in terms of percentage based on the total weight of the flaxseed including the dockage.

Dockage shall be stated in terms of whole percent. A fraction of a percent shall be disregarded. The word "Dockage", together with the percentage thereof, shall be added to the grade designation.

IV. Method for Dockage Determination in Flaxseed

Use a representative portion of the original sample of sufficient quantity to provide at least 1 1/8 quarts of mechanically-cleaned flaxseed for the test-weight determination.

The determination of dockage in flaxseed requires two principal steps in procedure in the following order: (1) a mechanical separation with appropriate sieves and cleaning devices, and (2) a hand-picking separation of a portion of the mechanically-cleaned flaxseed.
(a) Mechanical Separation
In making the mechanical separation, use any combination of sieves and cleaning devices best suited to remove the type of foreign material present in the sample, reclaiming any flaxseed removed with the dockage by rescreening over appropriate sieves.

(b) Hand Separation
The mechanically-cleaned flaxseed shall then be run through the Börner sampler and a portion, consisting of from 10 to 15 grams, shall be analyzed (hand picked) to determine the remaining dockage.

(c) Computation of Total Dockage
In computing the total actual dockage, all dockage obtained by the use of mechanical equipment shall be computed on the basis of the sample as a whole. The percentage of dockage removed by hand-picking, determined on the basis of the weight in grams of the portion used for the hand separation, must be multiplied by the fractional proportion of flaxseed remaining after the removal of the mechanically-separated dockage. For example, in a given sample the mechanically-separated dockage amounts to 10 percent, thus the fractional proportion of flaxseed remaining after the removal of the mechanically-separated dockage is 90 percent. The percentage of dockage found in hand-picking the 15-gram portion, for example 2 percent (15-gram base), should be multiplied by 90, which gives 1.8 percent of dockage on the basis of the original sample, and which should be added to the 10 percent of dockage obtained by mechanical separation, thus giving the total actual dockage for the entire sample as 11.8 percent.

Illustration:
Original sample = 1,000 grams. Mechanically-obtained dockage = 100 grams or 10 percent.
Original sample less 10 percent is 90 percent.
15 grams analyzed gives 0.3 gram dockage or 2 percent (15-gram base).
2 percent multiplied by 90 equals 1.8 percent (basis original sample).
10 percent mechanically-obtained dockage plus 1.8 percent hand-picked dockage equals 11.8 percent total actual dockage (11 percent assessed dockage).

Definitions

1. Basis of Grade Determinations.—Each determination of test weight, moisture, damage, and "firo damaged," shall be upon the basis of the grain after the removal of that part of the dockage which can be removed readily by the use of appropriate sieves and cleaning devices. All other determinations shall be upon the basis of the grain as a whole.
2. Percentages.—Percentages, except in the case of moisture, shall be percentages ascertained by weight.
3. Percentage of Moisture.—Percentage of moisture shall be that ascertained by the air oven and the method of use thereof described in Service and Regulatory Announcements No. 147, of the Bureau of Agricultural Economics of the United States Department of Agriculture, or ascertained by any device and method which give equivalent results in the determination of moisture.
4. Test Weight per Bushel.—Test weight per bushel shall be the weight per Winchester bushel as determined by the testing apparatus and the method of use thereof described in Bulletin No. 1065, dated May 18, 1922, issued by the United States Department of Agriculture, or as determined by any device
and method which give equivalent results in the determination of test weight per bushel.

5. Damaged Flaxseed.—Damaged flaxseed shall be seeds and pieces of seeds of flaxseed which are heat damaged, sprouted, frosted, badly ground damaged, badly weather damaged, or otherwise materially damaged.

VI. Laboratory Instructions

1. Secure a sample of flaxseed and determine dockage.
2. Determine test weight.

VII. Questions to be Answered

1. What is the U. S. standard bushel weight for flaxseed?
2. What forms of damage are found in flaxseed?
3. How is dockage calculated?

References

Exercise 15

Grading Pinto Beans

I. Classes for Dry Beans

For the purposes of the official standards, "beans shall be the dry threshed beans of any variety or kind of field and garden beans and which contain not to exceed 50 percent of foreign material including dockage and not to exceed 5 percent of foreign material after the removal of dockage."

The classes of beans are as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Kind of Beans</th>
<th>Class</th>
<th>Kind of Beans</th>
<th>Class</th>
<th>Kind of Beans</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Pea</td>
<td>VII</td>
<td>Great Northern</td>
<td>XV</td>
<td>Small Red</td>
</tr>
<tr>
<td>II</td>
<td>Light Red Kidney</td>
<td>IX</td>
<td>Butternut</td>
<td>XVI</td>
<td>Bayo</td>
</tr>
<tr>
<td>III</td>
<td>Dark Red Kidney</td>
<td>X</td>
<td>Pinto</td>
<td>XVII</td>
<td>Cranberry</td>
</tr>
<tr>
<td>IV</td>
<td>White Kidney</td>
<td>XI</td>
<td>Small White</td>
<td>XVIII</td>
<td>Blackeye</td>
</tr>
<tr>
<td>V</td>
<td>Medium White</td>
<td>XII</td>
<td>Large White</td>
<td>XIX</td>
<td>Lima</td>
</tr>
<tr>
<td>VI</td>
<td>Marrow</td>
<td>XIII</td>
<td>Western Red Kidney</td>
<td>XX</td>
<td>Baby Lima</td>
</tr>
<tr>
<td>VII</td>
<td>Yelloweye</td>
<td>XIV</td>
<td>Pink</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

II. Grade Requirements for Pinto Beans

<table>
<thead>
<tr>
<th>Grade</th>
<th>General Appearance</th>
<th>Maximum limits of splits, damage, other classes, and foreign material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>U. S. No. 1</td>
<td>Well screened and of good natural color</td>
<td>4.5</td>
</tr>
<tr>
<td>U. S. No. 2</td>
<td>Well screened and may be slightly off color</td>
<td>7.0</td>
</tr>
<tr>
<td>U. S. No. 3</td>
<td>May be of a poor color</td>
<td>10.0</td>
</tr>
<tr>
<td>U. S. Sample grade</td>
<td>Sample grade shall be beans of this class which do not meet the requirements of any of the above grades or which contain over 18 percent moisture, or have any commercially objectionable odor, or are heating, or weavily, or otherwise of distinctly low quality.</td>
<td></td>
</tr>
</tbody>
</table>

1Other Classes.—The percentage limits here given for other classes apply only to beans that are of a contrasting color, size, and shape in relation to Pinto beans. An additional allowance of 5 percent in grade U. S. No. 1, 5 percent in grade U. S. No. 2, and 8 percent in grade U. S. No. 3 shall be made for other classes that are similar to Pinto beans in color, size and shape, and such additional allowance shall not be included in the percentage of "total splits, damage, other classes, and foreign material," or "total defects."
III. Procedure to Grade Pinto Beans

1. A sample of 500 grams should be used.
2. Sieve the sample over the corn (scalper) sieve to remove the dockage.
3. Hand pick the sample for (1) splits, (2) damaged beans, (3) inseparable foreign material, and (4) beans of other classes. Weigh each separation separately and determine the percentage based on the whole sample.

IV. Definitions

1. Basis of Determination.—All determinations of factors entering into the grading of a lot of beans and the testing of a lot of beans for dockage and/or defects shall be made upon the basis of a representative sample drawn in accordance with methods approved by the Chief of the Bureau of Agricultural Economics.

2. Percentages.—All percentages, except in the case of moisture, shall be ascertained by weight. Percentage of moisture shall be that ascertained by the water oven and the method of use thereof described in Service and Regulatory Announcements No. 147 of the Bureau of Agricultural Economics of the United States Department of Agriculture, or that ascertained by any device and method which give equivalent results in the determination of moisture.

3. Dockage shall apply only to thresher-run beans or beans which have not been cleaned and/or handpicked and shall include dirt, stones, weed seeds, chaff, cereal grains, and all other matter other than beans which can be readily removed by the use of appropriate sieves or cleaning devices, and shall not undeveloped beans and splits or pieces of beans which pass through a sieve with slotted perforations of one of the following dimensions with the smallest loss of marketable beans:

- 9/64 inch by 3/4 inch
- 10/64 inch by 3/4 inch
- 11/64 inch by 3/4 inch
- 12/64 inch by 3/4 inch
- 13/64 inch by 3/4 inch
- 14/64 inch by 3/4 inch

except that for classes of Lima, Baby Lima, and similar types, the sieve for which shall have round perforations either 20/64 inch, 22/64 inch, or 24/64 inch in diameter, and the type of sieve used in any case shall be stated on certificates issued.

The quantity of dockage shall be calculated in terms of percentage based on not less than a 1,000-gram portion of the original sample including the dockage. In calculating dockage fractional percentages of less than one-half of 1 percent shall be ignored.

4. Damage shall be all beans and splits or pieces of beans which are so badly injured or discolored by weather, frost, heat, insects, disease, or other causes as to affect seriously the appearance and quality of the sample.

5. Splits shall be beans which are split or broken, and shall include beans the halves of which are held together loosely and pieces up to three-
fours the size of whole beans, but shall not include beans with cracked seed coats or splits which are damaged.

6. Cracks shall be beans with visibly cracked seed coats and/or with all or a part of the seed coat removed and beans with less than one-fourth of the whole bean broken off, but shall not include such beans that are otherwise defective.

7. Foreign material shall include stones, dirt, weed seeds, cereal grains, and all matter other than beans.

8. Stones shall be rocks, stones, pebbles, shale, other concreted earthy matter, or other substances of similar composition and hardness that do not disintegrate in water.

9. Blistered beans shall be beans of classes Lima and Baby Lima showing a bursting or abrasion of the skin, sometimes resulting in a spreading apart of the bean.

10. Wrinkled beans shall be beans of classes Lima and Baby Lima which have deeply wrinkled skins and which are badly warped or misshapen.

11. Other classes shall be all beans other than the kind or class designated or predominating in the lot being graded, and which can be readily identified by seed characteristics but shall not include such beans that are defective except for cracked seed coats.

12. Well screened, as applied to the general appearance of beans, shall mean that the beans are free from such small, shriveled, undeveloped, split and broken beans and foreign material as can be removed readily in the ordinary processes of milling or screening.

13. Good natural color, as applied to the general appearance of beans, shall mean that the beans possess the color and appearance of new-crop beans grown, harvested, threshed, and prepared for market under normal conditions prevailing in the principal region of production of such beans.

14. Weevily beans shall be beans which are infested with weevils or other insects injurious to stored beans or which contain beans that have been damaged by such weevils or insects.

15. Grade designations.—The grade designation of any lot of beans shall include successively the letters "U.S.", the name or number of the grade, or the words "Sample grade", as the case may be, and the name of the class; provided, however, that thresher-run beans or beans which have not been re-cleaned and/or handpicked shall be certified as to quality without reference to grade, as hereinafter provided.

6. Federal Food and Drugs Act.—Nothing herein shall be construed as authorizing the shipment of beans in violation of the Federal Food and Drugs Act.
V. Laboratory Instructions

1. Take a sample of Pinto beans from the instructor and grade them.
2. Determine the grade and report the results.

VI. Questions to be Answered

1. What are beans under the official standards?
2. What is dockage in beans?
3. What constitutes damage in beans?
4. Under what conditions are Pinto beans placed in Sample Grade?
5. What is meant by "general appearance" in grading beans?

Reference

APPENDIX

1. Grain Grading Problems
2. Glossary of Technical Terms
PROBLEMS ON COMMERCIAL GRAIN GRADES

(Each sample should be considered as of the No. 1 grade on those factors which are not given. Each sample should be considered as grown east of the Rocky Mountains unless otherwise stated).

Give complete grade designation and grading factors.

WHEAT

1. Hard Red Winter
   Test weight 58.2#
   Dark, hard and vitreous 76%
   Moisture 14.8%
   Slightly sour
   Grade
   Factors

2. Soft Red Winter
   Test weight 58#
   Total damaged 3.0%
   Moisture 15.0%
   Grade
   Factors

3. Soft Red Winter
   Test weight 57#
   Total damaged 5.0%
   Moisture 14.0%
   5 green garlic bulblets in 1000 grams
   Grade
   Factors

4. Soft Red Winter
   Test weight 60#
   Total damaged 1.0%
   Moisture 14.4%
   Red Durum 2.0%
   1 green garlic bulblet in 1000 grams
   Grade
   Factors

5. Hard Red Winter
   Test weight 59#
   Total damaged 14.0%
   Moisture 11.3%
   Cracked kernels 14%
   Actual dockage 2.7%
   Dark, hard, and vitreous 79%
   Garlicky odor
   Grade
   Factors

6. Hard Red Spring
   After removing 3.0% dockage the dockage free sample contains Dark, hard, and vitreous 60%
   Red Durum 3.0%
   Humpback 13%
   Sprouted rye 6.5%
   Smutty odor
   Grade
   Factors
7. Hard Red Spring
   Test weight 60.4%  Grade ________
   Heat damaged 0.1%  Factors ________
   Dark, hard, and vitreous 40% ________

9. Durum wheat
   Test weight 50#  Grade ________
   Amber 76\%
   Moisture 14.6\
   Total damaged 2.0%
   Dockage 2.0\
   Red/Durum 2.0% ________

10. Red Durum Wheat
    Test weight 60#  Grade ________
    Total damaged 3.0%
    Red Durum 94.0%
    Hard Red Spring 6.0%
    Moisture 14.2% ________

11. Wheat
    Test weight 58#  Grade ________
    Common Durum 88%
    Red Durum 11%
    White wheat 1% ________

12. Durum wheat
    Test weight 60#  Grade ________
    Total damaged 3.0%
    Red Durum 95.0%
    Amber 5.0%
    30 smut balls of average
    size in 250 grams ________

13. Wheat - dockage free which
    contains:
    Common Durum 70%
    Red Durum 10%
    White Wheat 5%
    Hard Red Spring 15%
    Test weight 57#  Grade ________
    Total damaged 2.0% ________

14. Hard Red Winter
    Test weight 58#  Grade ________
    Common Durum 1.0%
    Red Durum 2.0%
    Dark, hard, and vitreous 76%
    Soybeans 2.0% ________
15. Dockage free wheat  
   Soft Red Winter 70%
   Hard Red Winter 30%
   Moisture 14.5%
   Test weight 59#  
   Grade ____________________________  
   Factors ____________________________

16. Dockage free wheat  
   Hard Red Winter 60%
   Soft Red Winter 40%
   Moisture 15.3%
   Test weight 59#  
   Grade ____________________________  
   Factors ____________________________

17. Hard Red Spring  
   Test weight 58.5#  
   Dark, hard, and vitreous 85%
   Total damage 1.9%
   Humpback 9%  
   Grade ____________________________  
   Factors ____________________________

18. Dockage free Soft Red Winter  
   Test weight 59.2 #  
   Other classes 9.2%
   Damaged barley 7.5%  
   Grade ____________________________  
   Factors ____________________________

19. A sample before removal of  
    dockage consists of  
    Hard Red Winter 88%; Rye 4%
    Oats 5%; Barley 3%;  
    Moisture 14.7%  
    Grade ____________________________  
    Factors ____________________________

20. A sample of Western grown  
    White wheat  
    Test weight 59.4#  
    Hard (not soft & chalky) 70%
    Other classes 9.5%
    Total foreign material 1%
    Club 14%  
    Grade ____________________________  
    Factors ____________________________
## CORN

(Class Yellow unless otherwise stated)

<table>
<thead>
<tr>
<th></th>
<th>Test weight</th>
<th>Grade</th>
<th>Factors</th>
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<td>1.</td>
<td>54#</td>
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<tr>
<td></td>
<td>Moisture 14.0%</td>
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<td></td>
<td>Foreign material 2.0%</td>
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<td>2.</td>
<td>55#</td>
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<td>Total damage 3.0%</td>
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<td>3.</td>
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<td></td>
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<td>Foreign material 3.6%</td>
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<td></td>
<td>Heat damage 0.5%</td>
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<td>4.</td>
<td>53.0#</td>
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<td></td>
<td>26% Flint</td>
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<td>5.</td>
<td>55.5#</td>
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<td>Total damage 5.8%</td>
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<td>6.</td>
<td>51.5#</td>
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<td>White 4%</td>
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<td>7.</td>
<td>54.5#</td>
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<tr>
<td></td>
<td>Moisture 20%</td>
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<td>Foreign material 5.0%</td>
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<td></td>
<td>Heat damage 1.0%</td>
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<tr>
<td></td>
<td>Musty</td>
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<td>8.</td>
<td>56#</td>
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<td></td>
<td>Total damage 10%</td>
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<td>9.</td>
<td>49#</td>
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<td></td>
<td>Heat damage 0.9%</td>
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<td></td>
<td>White 7.5%</td>
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<td>10.</td>
<td>53#</td>
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<tr>
<td></td>
<td>Sour</td>
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</tr>
</tbody>
</table>
1. Eastern grown
   Test weight 47.9%
   Sound Barley 95%
   Wild oats 3%
   Broken kernels 4.0%
   Moisture 13.6%
   Trebi barley 6.0%

2. Eastern grown
   Actual dockage 2.3%
   Unsuitable malting types 3.5%
   Thin barley (sizing) 14%
   Skinned and broken 3.0%
   Not bleached
   Mellow kernels ) 80%
   Not semi-steely )
   Test weight 46#
   Sound barley 98%
   Foreign material 2%
   Damaged kernels 5%
   No blight damage

3. Eastern grown Trebi variety
   Test weight 47%
   Sound barley 95%
   Broken kernels 4.0%
   Slight damaged barley 2.0%
   Dockage 0.8%
   Good natural color

4. Eastern grown sub-class B
   Test weight 47#
   Sound barley 83%
   Slight damaged barley 20%
   Badly stained

5. Eastern grown Malting Barley
   Test weight 47#
   Sound barley 97%
   Slight damaged barley 3.0%
   Weevily

6. Eastern grown
   Two-rowed barley 91%
   Moisture 14.8%
   Dockage 2.8%
   Test weight 49#
   Black barley 1.0%
7. Eastern grown sub-class B
   Test weight 47#  
   Broken kernels 4.0%  
   Stained  
   Black barley 0.5%  

8. Eastern grown barley  
   Yellow kernels 80%  
   Redi barley 2.0%  
   Bleached  
   Test weight 43#  

9. Eastern grown  
   Actual dockage 2.5%  
   Unsuitable malting types 5.0%  
   Thin barley (sizing) 10%  
   Skinned and broken 4.0%  
   Damaged barley 3.0%  
   Yellow kernels 76%  
   Wild oats 2.0%  
   Sound barley 95%  
   Test weight 48#  

10. Eastern grown  
    Test weight 40#  
    Otherwise qualifies for malting barley  

11. Eastern grown  
    Test weight 46#  
    Sound barley 94%  
    Broken kernels 6%  

12. Barley 63%  
    Oats 25%  
    Wheat 2%  
    Foreign material 10%  
    Test weight 43#  
    Moisture 15.0%
WESTERN BARLEY

(Each sample should be considered as of the No. 1 grade on those factors which are not given. Each sample should be considered as grown west of the Rocky Mountains.)

Give complete grade designation and grading factors.

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<thead>
<tr>
<th>Sample</th>
<th>Test weight</th>
<th>Grade</th>
<th>Factors</th>
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<tr>
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<td>45# Sound barley 97%</td>
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<tr>
<td></td>
<td>97%</td>
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<td></td>
<td>Wild oats 2.0%</td>
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<td></td>
<td>Foreign material 1.0%</td>
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<td></td>
<td>Broken kernels 3.0%</td>
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<td></td>
<td>Bright</td>
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<td></td>
<td>Dockage 0.9%</td>
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<td>Grade</td>
<td>Factors</td>
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<td>2.</td>
<td>43.5# Sound barley 93.0%</td>
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<td></td>
<td>93.0%</td>
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<td></td>
<td>Moisture 14.0%</td>
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<td>Slightly stained</td>
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<td>Dockage 1.6%</td>
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<td></td>
<td>Oats 2.0%</td>
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<td>Grade</td>
<td>Factors</td>
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<td></td>
<td>Dockage 0.6%</td>
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<td></td>
<td>22.0% Two-rowed</td>
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<td>4.</td>
<td>46.0# Sound barley 93.0%</td>
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<td></td>
<td>93.0%</td>
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<td></td>
<td>Broken kernels 5.5%</td>
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<td>Stained</td>
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<td></td>
<td>Dockage 1.4%</td>
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<td></td>
<td>Skinned kernels 5.0%</td>
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<td>Grade</td>
<td>Factors</td>
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<tr>
<td>5.</td>
<td>50.0# Sound barley 89.0%</td>
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<td></td>
<td>89.0%</td>
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<td></td>
<td>Other classes 5.0%</td>
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<td></td>
<td>Bright</td>
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<td></td>
<td>Smut 0.7%</td>
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<td></td>
<td>Dockage 0.8%</td>
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<td>Two-rowed 90.0%</td>
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<td>Grade</td>
<td>Factors</td>
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<td>6.</td>
<td>42.0# Sound barley 97.5%</td>
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<tr>
<td></td>
<td>97.5%</td>
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<tr>
<td></td>
<td>Moisture 13.5%</td>
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<td></td>
<td>Heat damaged 0.3%</td>
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<td></td>
<td>Foreign material 2.0%</td>
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<td></td>
<td>Badly stained</td>
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<tr>
<td></td>
<td>Dockage 1.9%</td>
<td></td>
<td></td>
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</tbody>
</table>
7. Test weight 35#  
   Sound barley 96.0%  
   Moisture 13.6%  
   Weathered  
   Smut 0.3%  
   Dockage 0.4%  

6. Test weight 33.5#  
   Sound barley 93.0%  
   Moisture 15.1%  
   Wild oats 2.0%  
   Bright  
   Dockage 0.3%  

9. Test weight 33.5#  
   Sound barley 96.0%  
   Moisture 15.0%  
   Wild oats 2.0%  
   Bright  
   Dockage 0.3%  

10. Test weight 49.0#  
    Sound barley 74.0%  
    Moisture 13.8%  
    Wild oats 10.0%  
    *Stained  
      Smut 0.2%  
      Wheat 16.0%  

11. Test weight 47#  
    Sound barley 95%  
    Broken kernels 4.0%  
    Dockage 0.8%  
    Good natural color  

12. Test weight 48#  
    Two-rowed barley 91%  
    Moisture 14.3%  
    Dockage 2.8%  
    Black barley 1.0%  

13. Test weight 47#  
    Broken kernels 4.0%  
    *Stained  
    Black barley 0.5%  

*Refers to the general appearance of the sample, and is not the special grade designation "Stained"

Issued from General Field Headquarters June 22, 1954.
GLOSSARY OF TECHNICAL TERMS

A
Abortive - Imperfectly formed or rudimentary.
Acme - A one-seeded, dry, indehiscent fruit in which the testa and pericarp are not firmly attached.
Acicular - Needle-shaped.
Acropetal - Developing from the outside (below) toward the inside (above).
Acuminate - Tapering at the end.
Acute - Sharp pointed.
Adnate - Adhering closely.
Adventitious - Out of the ordinary place, as applied to buds or roots.
Aggregate - A mass or assemblage.
Agrostology - The branch of systematic botany which treats of grasses.
Alcune - Nitrogen particles found in definite layers in seeds.
Alluvial - Pertaining to deposits made by flowing water.
Alternate (buds, flower parts, leaves, etc.) - One after another singly at the nodes.
Anastomosing - Joining or uniting.
Androecium - The stamens collectively.
Annual - Of one year's duration.
Annular - Forming a ring or circle, as embryo of beet.
Anther - The part of the stamen which contains the pollen.
Anthesis - The time of expansion of a flower.
Apetalous - Without petals, as in buckwheat, etc.
Apex - Tip, point, angular summit.
Apiculate - With a minute pointed tip.
Appendages - Something added to a greater thing.
Appressed - Lying, close and flat against.
Appressed-hispid - Rigid hairs lying flat or close against a surface.
Aristate - Tipped by an awn or bristle.
Articulate - Jointed.
Articulations - Joints.
Ascending - Rising obliquely - curving upward.
Asymmetric - Not symmetrical.
Attenuate - Tapering - becoming very narrow.
Auricle - Ear-like structure.
Autogamy - Pollination in which pollen is transferred from the anthers to the stigma of the same flower.
Awn - A slender bristle-like organ.
Axis - A line passing thru a structure about which the parts are arranged.

B
Barb - A rigid point or short bristle.
Barbed - Furnished with barbs.
Beaked - Ending in a prolonged tip.

1Made up from the Glossary used by Anna H. Lutz, Botany Department, Colorado State College, in the "Grasses" course, together with the one in "Botany in Crop Plants" by W. W. Robbins, pp. 609-618.
Bearded - Bearing long or stiff hairs.
Sicconvex - Doubly convex - i.e., convex on both sides.
Bidentate - Two toothed.
Biennial - Of two years' duration; the first year from seed, the second year flowering and fruiting, then dying; as in sugar beet.
Bifid - Two cleft.
Blade - The expanded portion of a leaf.
Bloom - The whitish, powdery, and waxy secretion of epidermal cells.
Bony-indurate - Much hardenr.
Bract - Small leaf belonging to inflorescence.
Bristle - Short, stiff hair.
Bulbous - Similar to a bulb; having a bulb.

C

Callus - The tough often hairy area at the base of the lemma.
Campanulate - Bell-shaped.
Capillary - Hair-like.
Capitate - Arranged in a head or dense cluster.
Capsule (pod) - A dry, achient fruit of two or more carpels.
Coriaceous - Having a feel, a longitudinal ridge.
Cartilaginous - Firm and tough.
Caryopsis - A seed-like fruit with the thin pericarp adnate to the contained seed.
Chartaceous - Having the texture of writing paper.
Chartaceous-indurate - Somewhat firmer than Chartaceous.
Ciliate - Marginally fringed with hairs.
Citation - Enumeration, mention.
Claw - The narrow or stalk-like base of some petals.
Cleft - Cut about half way to the middle.
Clavicyrous - Applied to flowers which do not open and are fertilized in the bud by their own pollen.
Coleoptile - Leaf sheath in grasses.
Colesorhiza - A sheath about the root.
Collar - The modified area between the sheath and blade of a leaf.
Compressed - Flattened.
Concavity - A hollow, a recess.
Coninate - United; used especially of similar organs.
Contiguos - Touching; in actual contact.
Contracted - Drawn together.
Convex - Bulging, arched out.
Convolute - Rolled up longitudinally.
Copious - Abundant.
Cordate - Heart-shaped.
Coricaceous - Leathery.
Coricaceous-indurate - Somewhat harder than leathery.
Cornate - Horned.
Corolla - The inner of two series of floral leaves.
Crateriform - In the shape of a saucer or cup.
Culm - The stem of grasses and sedges.
Cuticle - A thin covering of a waxy substance called cutin on the outer wall of epidermal cells.
Cylindric - Having the form of a cylinder.
Deciduous - Not persistent; falling away at maturity.
Descendent - Reclining; but with the tip ascending.
Dehiscence - The opening of a fruit or stamen.
Desiccatant - Splitting open.
Dentate - Sharp-toothed; tooth directed forward.
Denticulate - Diminutive of dentate; furnished with very small sharp teeth.
Depressed - Somewhat flattened from above.
Dihedral (stamens) - United into two sets, as in many legumes.
Dichogamy - A condition in which stamens and pistils do not mature simultaneously.
Diffuse - Widely or loosely spreading.
Digitate - Diverging like the fingers spread.
Dioscious - Bearing staminate flowers on one plant and pistillate on another.
Disarticulate - To come apart at a joint.
Distichous - Arranged in two rows.
Divaricate - Diverging at a wide angle.
Divergent - Deviating gradually from a given angle.
Dorsal - On the back.
Dorsiventral - From back to front.

Eccentrically - Deviating from the center.
Ellipsoid - A solid body elliptic in section.
Elliptic - Oblong with rounded ends.
Elongate - Lengthen.
Emarginate - Notched at the apex.
Embryo - Rudimentary plant within the seed.
Endosperm - Nutritive tissue formed within the embryo sac in seeds.
Entire - Without divisions, lobes or teeth; usually refers to margins of leaves, petals, and sepals.
Erode - Margin irregular, as if gnawed.
Erode dentate - Irregularly toothed.
Etiolate - To whiten, or bleach, by the exclusion of light.
Evanescence - Tending to disappear.
Excurrent - Running out as a nerve of a leaf running out beyond the margin.
Exserted - Protruding past surrounding ovules.
Extravaginal - Referring to branches in grasses which force their way out thru the base of the leaf sheath.

Falcate - Shaped like a scythe.
Pedicel - A dense cluster.
Fertile - Capable of bearing fruit or seed; applied to flowers with pistils or to stamens with pollen.
Fertilization - A sexual process in which two dissimilar gametes fuse.
Fibrous - Fiber-like, usually referring to root system of many small thread-like roots.
Filament - Thread; stalk of stamen.
Platycarpeus

Placentation: - Fan-shaped.
Flammea - Bending.
Florate - A small flower.
Follicular - Leaf-like in texture or appearance.

G

Gleitogamy - A method of pollination in which pollen is taken from anther to stigma of another flower on same plant.
Glabrous - Smooth, without hairs.
Glandular - With glands.
Globular - Spherical or nearly so.
Glumes - Bracts at the base of a spikelet.
Gregarious - Growing in groups or colonies.
Gynoecium - The carpels taken collectively.

H

Halophytic - Growing naturally in saline soils.
Head - An indeterminate type of inflorescence in which the flowers are in a dense cluster, as in Compositae.
Herbaceous - Herb-like; that is, stems do not develop woody tissue.
Hermaphrodite (flowers) - Perfect, both stamens and pistils present.
Heterogeneous - Dissimilar.
Hilum - The scar left by breaking the attachment of a seed in the fruit.
Hispid - With rigid or bristly hairs.
Hispid-ciliate - With bristles on the margin.
Hyaline - Thin and translucent.
Hydrophytic - Growing in water or saturated soil.
Hypostomatic - Readily absorbing and retaining moisture.
Hypocotyl - That portion of the embryo stem below the cotyledons.
Hypogynous - Ovary superior; flower parts attached below the ovary.
Hirsute - Covered with stiff hairs.
Homogamy - The anthers and stigmas mature at the same time.

I

Indehiscent - Not splitting open.
Imbricated - Overlapping.
Indigenous - Native to the region of growth.
Indurate - Hardened.
Inferior (ovary) - Below the other flower parts.
Inflated - Hollow and distended.
Inflated saccate - Distended in sac shape.
Inflated ventricose - Inflated or swollen on one side.
Inflorescence - The flowering parts of plants.
Inrolled - Rolled from edges toward middle.
Integument - Skin; coat of protecting layer.
Internode - Portion of a culm between two nodes.
Intervaginal - Referring to branches in grasses which grow out between the leaf sheath and the culm (stem).
Involute - A whorl of bracts surrounding a flower or a cluster of flowers.
Involucral - Rolled inwardly.
Irregular (flower) - One or more of the parts of a series are dissimilar.

I

Keel - A central ridge like the keel of a boat.

L

Laciniate - Cut into narrow lobes or segments.
Lanceolate - Several times longer than wide, tapering from base to apex.
Lanceolate - Tweedy.
Lemma - The lower of the two bracts enclosing a grass flower.
Lenticular - Shaped like a double-convex lens.
Ligulate - Strap-shaped.
Ligule - A thin projection from the summit of the sheath in grass leaves.
Linear - Long and narrow, its sides nearly parallel.
Lobed - Divided to about the middle.
Lodicule - A delicate scale inside of the palea, properly in a vestigial perianth.
Lunate - Crescent-shaped.

M

Marginal - Near the edge.
Medulla - Pith.
Membranaceous - Thin, rather soft, more or less translucent.
Mesocotyl - Axis between base of coleoptile and grain, in grasses.
Mesophyte - A plant growing under medium moisture conditions.
Midrib - Central vein or rib of a leaf or bract.
Moniliform - Like a string of beads.
Monocious - Bearing stamens and pistils in separate flowers on the same plant.
Monotypic - A tribe with only one genus or a genus with only one species.
Mucro - An abrupt point or tip.
Mucronate - Having a mucro.

N

Naviculare - Boat shaped.
Nerve - Vein.
Neuter - Having imperfect stamens or pistils.
Node - The junction of two internodes in a culm; point of origin of a leaf.
Nucellus (megasporeangium) - The ovule tissue within the integuments.
Obovate - Heart-shaped, with broad end at the tip.
Oblong - Longer than broad with sides nearly parallel.
Oblanceolate - Lancolate with broadest part toward the apex.
Obovate - Eggs shape with broadest part toward the apex.
Obcoate - Gone, or vestigial.
Obtuse - Blunt or rounded.
Ovary - The ovule bearing part of the pistil.
Ovate - Eggs shaped, broadest part at base.
Ovule - The structure which after fertilization becomes the seed.

P

Pedicellate - Borne on a pedicel.
Pedicel - The stalk of a single spikelet.
Peduncled - A stalk supporting a single spikelet or a branch.
Pendant - Hanging.
Perennial - Living year after year.
Perfect - Having both stamens and pistil in each floret.
Perianth - The floral envelope (calyx and corolla).
Pericarp - The matured ovary.
Peristent - Long continuous; not deciduous.
Pedicle - The stalk of a leaf.
Pinnate (leaf) - Leaflets arranged along the sides of an axis.
Pistil - The seed bearing organ of a flower.
Pistillate - Having a pistil.
Plano-convex - Plane on one side, convex on the other.
Plumose - Having fine hairs like a feather.
Prostrate - Lying flat on the ground.
Protandry - In which the anthers of a flower shed their pollen before the stigmas are receptive.
Protoxyony - In which the stigmas of a flower are receptive before its anthers shed their pollen.
Puberulent - Minutely pubescent.
Pubescent - Covered with soft hairs.
Pyramidal - Shape of a pyramid.
Prototype - Primary form and pattern.
A

Raceme - A simple inflorescence with spikelets borne on pedicels along an axis.
Racemose - In racemes.
Rachilla - The axis of a spikelet.
Rachis - The main axis of grass inflorescence.
Radical - Seeming to come from the root. Leaves arising from the base of stem, close to the ground line, and said to be radical, as contrasted with those on the stem (cauline).
Recurved - Curved backward.
Reflexed - Bent backward abruptly.
Regular (flower) - The parts of each whorl similar.
Reniform - Kidney-shaped.
Reticulate - Netted.
Retorsely - Turned backward or downward.
Rhizomes - A subterranean stem.
Rigid - Stiff, not flexible.
Ruderal - Growing in waste places; weed.
Rudiment - A beginning.
Rugose - Wrinkled.

Runner - A prostrate, slender, above-ground stem, such as in the strawberry.

S

Saccate - Sack-shaped.
Scabrous - Rough to the touch.
Scale - Reduced leaf that appears lower on the stem than the foliage leaves.
Scarious - Thin, dry, membranaceous, not green.
Sclerotic - Hard, indurate.
Scutellum - Morphologically, the cotyledon of the grass embryo.
Seminal - Belonging to the seed.
Serrate - Finely serrate.
Sessile - Without stalk of any kind.
Setaceous - Bristle-like.
Sheath - A tubular envelope.
Spicate - Spike-like.
Spike - A simple inflorescence with spikelets borne sessile along a rachis.
Spikelets - A group of florets subtended by one or more glumes.
Squarrose - Rough with divergent processes.
Stamen - One of the pollen bearing organs of a flower.
Staminate - Bearing stamens.
Standard - The large petal in the flowers of Leguminosae.
Sterile - Flower without pistil, stamen without stamens.
Stigma - The part of a pistil to which pollen grains become attached.
Stipe - Stalk.
Stipitate - Having a stalk.
Stolon - A trailing stem, above ground, that easily takes root at the nodes when it touches the ground.
Stooling - Production of secondary branches from lowermost nodes, as in grass tillering.
Stramineous - Straw-colored.
Strigose - With appressed or ascending stiff hairs.
Subacute - Somewhat acute.
Subcircular - Somewhat rounded.
Subcylindric - Somewhat cylindrical.
Subdigitate - Somewhat digitate.
Subglabrous - Somewhat glabrous.
Subglobose - Somewhat spherical.
Subscarios - Somewhat scarious.
Subsessile - Nearly sessile.
Subsimple - Nearly simple.
Subtend - To grow under, or be adjacent to, as a bract subtending a flower.
Subterete - Nearly terete.
Subulate - Awl shape.
Subvelutinous - Slightly velvety.
Succulent - Soft and juicy.
Sucker - Rapidly growing shoots from roots or from stems underground.
Superior (flower) - Ovary appearing above the other parts of the flower.
Suppressed awn - Nearly obsolete awn.
Sypetalous - Petals united.
Suture - A line of splitting.

T
Tassel - Stamineate inflorescence in corn.
Taxonomy - Classification.
Tendril - Slender, coiled organ used in climbing.
Terete - Having a circular cross section.
Terminal - At the end.
Testa - Seed coat.
Tillering - Production of branches from the lowermost nodes, as in grasses.
Tomentose - Covered with dense wool-like hair.
Translucent - Partially transparent.
Trifid - Three parted.
Trifoliate - With three leaflets, as in clover.
Truncate - Ending abruptly.
Tufted - In bunches.
Turgid - Tightly drawn, swollen.
Tussock - Tuft, dense bunch.

U
Undulate - With wavy margin.
Unilateral - One sided.
Utricle - Small bladdery one seeded fruit.

V
Veination - The arrangement of veins.
Ventral - The inner face of an organ.
Ventricose - Inflated on one side.
Ventral - Pertaining to spring.
Ventriculate - Thorned.
Vestigial - Remnant.
Villous - Bearing long soft hairs.

Wing - Lateral petal in the flower of Leguminosae.
Whorl - Arranged in a circle around a stalk.

Xerophytes - Plants adapted to dry situations.