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GRAIN GRADING PRIMER

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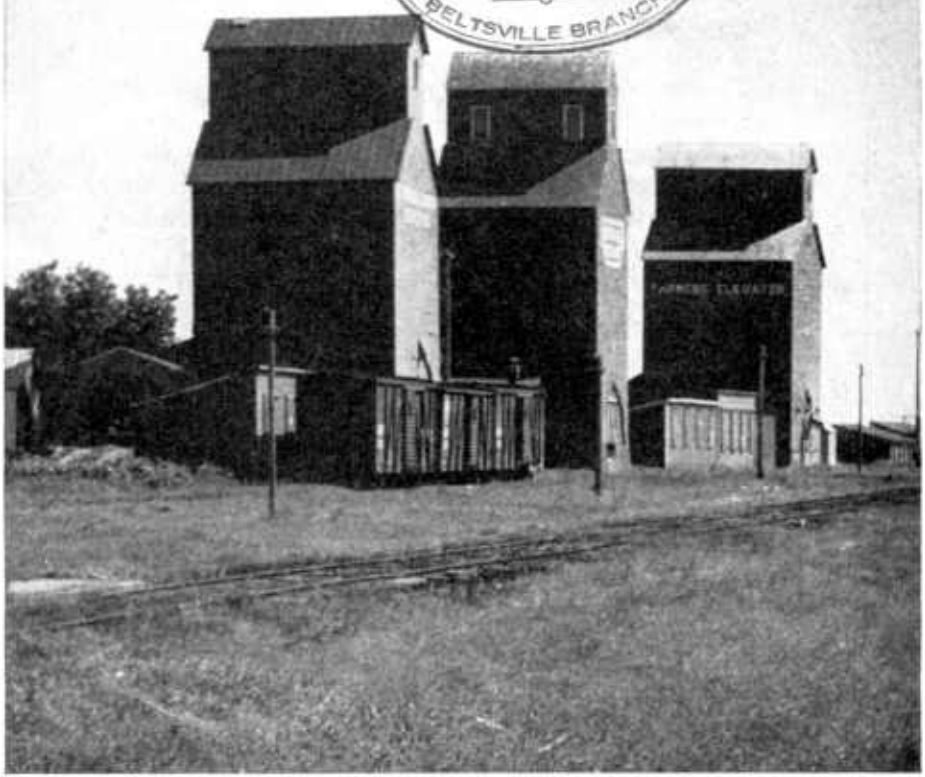

AGRICULTURE HANDBOOK NO. 59
U. S. DEPARTMENT OF AGRICULTURE

THE Grain Grading Primer is designed for grain farmers and country grain dealers who are interested in handling grain on a grade and quality basis and for marketing students. It is not designed for grain inspectors, for they must necessarily use a more precise and detailed grain-grading technique than that described herein.

A number of farm practices that lower the quality and grade of grain are briefly discussed in this publication. Methods and apparatus useful in measuring the value of grain are described and information on how to inspect and grade grain is given.

This revision of the Primer covers changes in the rye grades that became effective July 1, 1951. The new Malting grades for Hannchen and Hanna barley are included in appendix I, and a new section on grading procedures for each grain has been added as appendix II.

The Handbook of Official Grain Standards of the United States, for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 25 cents a copy, and other reference material listed on pages 59 and 60 of this Primer will provide useful supplementary reading.

This manual is a slight revision of Miscellaneous Publication 325.

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GRAIN GRADING PRIMER

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DEVELOPMENT OF GRAIN GRADING

As the Mississippi Valley was gradually brought under cultivation the surplus grain in increasing quantity moved eastward to consuming centers and to the eastern seaboard by rail, lake, river, and canal. There was need for a readily understandable commercial language to express the class, quality, and condition of individual lots of grain so that buyers and sellers at separate points could trade without a personal examination of the grain itself or without an exchange of samples. Grain trade organizations, therefore, instituted a system of grain grading whereby grain could be bought and sold by grade without having either the grain itself or samples of it before the interested parties.

Each trade organization adopted its own set of standards and its own method of application. The grades themselves were set forth in such ambiguous terms as "dry," "damp," "plump," "well-cleaned," "unsound," and "unmerchantable."

EARLY GRAIN-GRADING PRACTICES

In some markets different interests favored different kinds of grain standards. The millers generally preferred high standards, well-maintained, whereas other interests that made their profits mostly from the volume of grain handled, frequently favored liberal standards, leniently applied for the sake of attracting shipments to their market.

Persons buying grain under a certain designation in one market had little assurance that the grain would receive the same grade designation in some other market. Exporters who bought grain at interior markets for delivery abroad had no way of knowing that the grain bought by grade at interior points would be assigned the same grade when loaded aboard ship for export. Millers hesitated to make future contracts, to accept the grades of grain then specified. Sometimes they refused to accept such deliveries because they had no confidence in the way in which the standards had been applied. Indefinite grading and lack of confidence in grain grading had a strong tendency to depress prices of grain sold by grade, especially for deliveries that were to be made at some distant future date.

FEDERAL LEGISLATION

For many years grain organizations tried to bring about a more consistent application of uniform standards. But the results were disappointing. The lack of any effective agency to establish a single set of standards for grain that would be applicable throughout the United States and to insure uniform application, kept the grain-grading system defective during this period of localized and unrelated grain-inspection departments.

Foreign-trade organizations and individual receivers of American grain filed complaints with the United States Government on account of the unsatisfactory condition of graded grain received from American ports. But at that time the Federal Government had no jurisdiction over the numerous State and commercial grain-inspection departments operating throughout the country. In 1901 the United

States Department of Agriculture organized an investigational project for studying the structure of the commercial grain standards then in effect and the methods by which they were applied. As a result, in 1913, permissive Federal standards for shelled corn were established. Shortly afterward these standards were adopted by many grain-inspection departments even before the United States Grain Standards Act was passed in 1916. But a serious lack of uniformity in the application of the standards continued.

The demand for uniform grades and inspection resulted in the introduction, in the Fifty-seventh to the Sixty-fourth Congresses, covering the years 1903 to 1916, of 26 different bills providing either for Federal supervision of grain grading or for outright Federal grain inspection. Extended hearings were held on several of these bills. The United States Grain Standards Act was finally passed August 11, 1916.

The act provides in part for (1) the establishment of official grain standards, (2) the Federal licensing and supervision of the work of grain inspectors, and (3) the entertaining of appeals from the grades assigned by the licensed inspectors. The Secretary of Agriculture is authorized to make investigations and to establish Federal standards for the most common grains. Federal standards under this act are now in effect for wheat, corn, barley, oats, feed oats, mixed feed oats, rye, grain sorghums, flaxseed, soybeans, and mixed grain (*12*).[1]

GRAIN INSPECTION UNDER THE UNITED STATES GRAIN STANDARDS ACT

The Grain Standards Act provides in part that all grain shipped in interstate or foreign commerce to or from a point at which an inspector, licensed under the act, is located must be officially inspected and graded if the grain be merchandised by grade. As most of the grain that reaches any important grain market is moving in interstate or foreign commerce by grade, it is necessary, for practical purposes, that the grain inspectors hold Federal licenses to inspect and grade grain.

Most of the licensed grain inspectors are employed by States or trade organizations. They are paid salaries by the agencies that employ them. Some licensed inspectors work independently for fixed fees, paid by those who request these services. No licensed grain inspectors are employed by the Federal Government.

The grain-grading activities of all federally licensed grain inspectors are supervised by Federal grain supervisors employed by the United States Department of Agriculture and stationed at the important grain markets. In the first instance, grain is graded by a licensed grain inspector. Any person financially interested in the grade of any lot of grain may appeal from the grade assigned to it by a licensed inspector to the Secretary of Agriculture, through the local grain supervisor.

The provisions for uniform grain standards, the general supervision by the Federal Government of grain inspection, and the provision for appeals to Federal agents afford protection as to correct grading to all handlers of grain who wish to avail themselves of these services.

[1] Italic numbers in parentheses refer to Literature Cited, pp. 59 and 60.

USEFULNESS OF GRADES IN EXPORT COMMERCE

Since the Grain Standards Act has been in effect much grain exported from the United States has been sold on the basis of the official standards, evidenced by inspection certificates issued under the act. When grain is sold by grade and on the basis of "United States certificate final," all questions as to the grade of the grain delivered are settled when the grain is graded for export. The exporter is not required to assume any further risk from arbitration or from any subsequent grading.

BENEFITS OF STANDARDIZATION

Grain grading permits the great economy of bulk storage and transportation of grain of similar grades. It facilitates financing and trading on the basis of warehouse certificates representing grain of known quality and value. It establishes loan values for grain in farm storage.

Grain grading, and market quotations based on grade, assist producers and handlers of grain to market their grain advantageously.

The application of the grain standards shows the causes for market discounts and indicates ways and means for crop-improvement and grain-handling practices that will bring about a reduction of certain "off" grades of preventably low quality.

Grain standards function as commercial measures of quality and condition. They assist in the economical marketing of grain because their use reduces risks and promotes definite agreements between contracting parties.

S. J. Duly, of the City of London College, who has made a special study of the grain trade and is a recognized authority on grain merchandising, comments on the benefits of standardization on page 83 of his book, entitled "Grain" (*8*), as follows:

> The advantages of the grading system are many. It is essentially a farmer's system. It is his safeguard. Grading takes place in the country of production and it provides the required incentive to the farmer to farm well, since he has the assurance that his return will be determined by the quality of his crop. His grading certificate provides him with bank credit immediately. Then grading is the absolute prerequisite of bulk handling. If grain is not graded, it cannot be bulked with other grain, but must retain its identity and be sampled frequently for selling purposes. The immense economy of the terminal storage system is only possible after dependable grading. Next, it provides the basis upon which organized marketing with future sales and hedging alone becomes possible. This forms the most economic machinery for financing the crop, paying cash to the farmer months before the grain is exported, holding it, transporting it, and getting it to the miller. Finally, it provides the last buyer with a standard article upon which he may depend, in the same manner that buyers depend on the trade-mark of manufactured goods of reputable firms.
>
> The main disadvantage from the point of view of a European buyer is the impossibility of disputing the grade and securing arbitration upon questions of quality or condition when once the grain is sold on grade for shipment abroad. It thus appears to be essentially a system of an exporting country. It only becomes a possible international system on certificate final terms when experience shows (as it does) that the grading in the exporting country is entirely dependable.

USING THE GRADES AT COUNTRY POINTS

Most country shippers try to pay premium prices for grain of superior quality. The difficulties encountered in attempting to purchase

inferior grades at a discount are admitted. To buy grain fairly it is necessary to recognize its quality at the time the purchase is made. It is almost a necessity that country grain dealers be able to grade grain.

Country grain dealers and farmers insist, and rightly so, that grain standards be plain and simple so that it will be possible to apply them at country points. The official standards, however, must be extensive enough to cover all the various classes and qualities of grain everywhere in the United States. But at most country points only a limited number of grades are produced and handled in any one season.

In striving for quick and easy methods care must be taken not to reduce the grading to mere guessing. For most determinations of quality the only practical procedure is to secure grading equipment and make the tests in the same manner that is followed by experienced grain inspectors.[2] The standard methods for grading grain, worked out as a result of long experience in grain inspection organizations, are not complicated or involved, and are practical of application. It is these standard methods on which the material in this publication is based.

TESTS ON WHICH VALUES IN GRAIN ARE BASED

Some of the tests of grain quality that producers and consumers have always considered important are tests for plumpness, soundness, cleanliness, dryness, purity of type, and the general condition of the grain.

Plumpness is measured by the weight-per-bushel test, supplemented by sizing tests for some grains. Soundness is indicated by the absence of musty, sour, or commercially objectionable foreign odors and by the quantity of damaged kernels that are present in the grain. Cleanliness is measured by determining the foreign-matter content. Dryness is determined by making a moisture test. Purity of type is provided for by classes for the various grains and by limitations for admixtures of other grains or of other classes of the same grain.

"Condition" is a general term and refers to whether the grain is in sound condition or is out of condition because it is musty, sour, or heating. Condition is also indicated by such designations as "smutty," "garlicky," "weevily," "bright," "stained," "tough," or "treated." These terms describe various conditions in which grain is sometimes found.

An explanation of the class, quality, and condition factors and how they are applied in practical grain inspection is the principal objective of this publication.

OBTAINING THE SAMPLE

The first essential step in grading grain is to obtain a correct and representative sample of the lot of grain to be graded. The basic instructions issued by the United States Department of Agriculture on this subject provide for a sample of not less than approximately 2 quarts in size.[2]

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[2] Grain Inspectors' Manual. United States Department of Agriculture, Production and Marketing Administration, Grain Branch. 175 pp. 1942. [Processed.]

CARLOT, WAGON, OR TRUCK LOTS

In the case of bulk grain in a car, truck, or wagon, or in any other container in which the grain is about the same depth as in a carload, the sample is taken with a double-tube compartment trier 62⅞ inches long (see fig. 15, *A*, p. 51) 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 the car, truck, or other container. In the discretion of the sampler as many more probings as may be necessary are to be taken from the grain in different parts of the lot.

As each probe of grain is drawn, the grain is emptied upon a canvas for examination (fig. 1). If after examination of the separate probes, no material portion of the grain is found to be distinctly inferior to the remainder of the grain, the grain from the separate probes is combined as an average sample of the grain involved. If the time to elapse

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FIGURE 1.—A sampler emptying the grain from a probe upon a canvas for careful examination regarding mixtures, odors, and evenness of loading.

between the drawing of the sample and the determination of grade would permit of such changes in the condition of the sample as to affect the grade, a representative portion of at least 1⅛ pints of the grain should be enclosed in an airtight container. At country elevators a pail with a tight cover to hold the entire sample is often used for an airtight container.

In the Pacific Northwest a sampler for cutting the grain stream as it falls from a truck has been developed.

BINS AND SACKS

In the case of bulk grain in bins and warehouses where the depth of the grain is so great as not to permit thorough probing with a trier of either standard or special length, or where conditions make it hazardous for a person to enter the bin, such grain should be trans-

ferred and samples taken from a falling stream of grain pouring into or from such bin. Samples from the falling stream are taken with a device known as a spout sampler or "pelican" (see fig. 16, p. 53) or with any other device that gives equivalent results.

In the case of grain in sacks, samples are drawn from as many individual sacks, selected at random throughout the lot, as will enable the sampler to procure a representative sample of the entire lot. The samples are taken by any approved trier of sufficient length to reach the center of the sack (see fig. 15, *C*, p. 51).

GRADING PROCEDURE IN GENERAL

In the commercial grading of grain the lot as a whole is examined at the time of sampling for the condition factors of temperature and odor, infestation of live weevils, and any other noticeable factor not requiring a detailed analysis. When the samples are brought to the inspection office, dockage tests, weight-per-bushel tests, and moisture tests are usually made first. Further analysis is made for such grading factors as a careful examination of the sample indicates may be important. In making further tests a representative portion of the sample is taken from either the mechanically cleaned grain or from the sample as a whole, as governed by the basis of determination of the standards.

Identification: Factor:		*Test or analysis*	*Grade* [1]
Temperature (heating)			
Odor (musty, sour, commercially objectionable foreign odors)			
Weevils			
Dockage	percent		
Class			
Subclass			
Other classes	percent		
Test weight	pounds		
Total damaged	percent		
Heat-damaged	percent		
Blighted	percent		
Foreign material	percent		
Matter except other grains	percent		
Moisture (tough, sample grade)	percent		
Garlicky (light garlicky, garlicky)			
Smutty (light smutty, smutty)			
Appearance [2]			
Special [3]			
Miscellaneous			

[1] This column will show the grade for each factor tested. The final grade, appearing on the inspection certificate, is not the average of these grades, but is the lowest grade appearing in the column. For example: A lot of wheat might qualify for the No. 1 grade on every other factor but contain 2 percent of heat-damaged kernels, and hence will grade No. 5.

[2] Appearance includes special grades for bright, stained, bleached, discolored, and treated.

[3] Special includes special grades for flint, two-rowed, and thin.

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The beginner should have a chart or a form somewhat like the one shown herewith to record his findings, based on his analyses and other observations. When the analyses are finished, the grader ascertains the grade of the grain by comparing the results of the analyses and other tests with the requirements of the standards for the kind of grain being graded.

It is impracticable in this publication to enumerate all the details of how to grade samples of all the grains, because in some instances the grader must determine several factors, whereas in other cases only one or two determinations may be necessary. This circumstance may be illustrated by a damp sample of pure white corn which is clean and which contains only a few damaged kernels. In this instance it is obvious that the grader need only determine the percentage of moisture to ascertain the true grade of the corn.

As a further illustration, after the dockage has been removed in grading wheat, it is frequently unnecessary to make more determinations than the weight-per-bushel test. Any additional testing or analyses made on such samples would merely furnish supplemental information without having any effect upon the grade.

In the actual grading of commercial grain the experienced grader has a great advantage over the beginner in accomplishing more and better work with less effort, because he knows from a general examination of the sample what factor or factors he should determine and what factors he may disregard. To become an efficient grader of grain the beginner should follow an orderly procedure so that he may not overlook any of the factors that may indicate one of the lower grades.

At this point it may be well to state that in assigning the higher grades to grain, caution must be used because the factors in the higher numerical grades of all grain have much smaller tolerances than the factors in the lower grades. On the other hand, in the lower grades there is usually one outstanding factor that will degrade any given lot or parcel of grain, and in such cases the other factors have no effect whatever upon the grade that is to be assigned to the grain.

ANALYTICAL PORTIONS

In the standard grain-inspection procedure all determinations that are based on fractional parts of a sample are made on standard-sized portions (table 1) cut from the sample by means of the Boerner divider (fig. 2). When the grade of any lot of grain is determined by a narrow margin, on a single grading factor, another determination is made on an additional portion and the grade is based on the average of the two determinations.

All percentages, except moisture, are percentages by weight. Percentages based on count would be inaccurate. Balances similar to those illustrated in figure 17 are essential.

Tables for converting the weights of mechanical separations of grain into percentages, given in Department of Agriculture Circular No. 623, are convenient for use in connection with any determinations based on mechanical analysis (*3*).

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FIGURE 2.—Boerner divider used for separating grain samples into representative portions.

TABLE 1.—*Minimum quantity of grain in analytical portions recommended for inspection work*

[Quantities in grams (metric) unless otherwise stated]

Determination for—	Wheat	Corn	Oats	Rye	Barley	Grain sorghums	Flaxseed	Soybeans
Blight					30			
Class	25	250	25		30	25		125
Color and texture	25							
Cracked corn and foreign material [1]		[4] 1⅛				[2] [4] 1⅛		
Dockage [3]	[4] 1⅛			[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] [5] 1⅛	
Ergot	250		250	250	250			
Foreign material	50		30	50	30			125
Garlic	1,000		500	1,000	500			
Heat damage	50	250	30	30	[6] 50	50	20	
Kind of grain	50	250	30	50	30	50	25	125
Mellow					[6] 50			
Nongrain sorghums						50		
Shrunken and/or broken kernels:								
All classes (except Durum and Red Durum)	250							
Durum and Red Durum	[7] 50							
Sizing			[4] 1⅛	250	([8])			
Skinned and broken					30			
Smut	250		500	250	500	250		
Smut dockage	500							
Sound			30		30			
Splits								125
Stones and cinders	[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] 1⅛		[4] 1⅛
Total damaged	50	250		30	30	50	20	125
Two-rowed					30			
Weevil	[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] 1⅛	[4] 1⅛		[4] 1⅛
Wild bromegrass			[4] 1⅛		[4] 1⅛			
Wild oats			30		30			

[1] Refers to "total cracked kernels, foreign material, and other grains" for grain sorghums.

[2] 50 grams of sieve-cleaned grain are also hand-picked for additional foreign material and other grains.

[3] A sufficient quantity is used to provide at least 1⅛ quarts of grain for the weight-per-bushel test.

[4] Quarts.

[5] At least 15 grams of sieve-cleaned grain are also hand-picked for additional dockage material.

[6] Weight before pearling.

[7] In Durum and Red Durum wheat the sieving operation is supplemented by hand picking of the broken kernels that do not pass through the sieve.

[8] One-fourth of dockage-free sample.

CLASSES AND SUBCLASSES

There is no mechanical test for determining the class to which any particular lot of grain belongs. Identification of the different classes of grain depends almost entirely upon the grader's knowledge of and familiarity with the different kinds of grain that come under his ob-

servation. Color, kernel texture, and variety characters are helpful indexes in determining the class or subclass of many of the grains.

Table 2 shows the classification of all the grains for which standards have been established under the provisions of the United States Grain Standards Act.

TABLE 2.—*Classes, subclasses, and areas of production*

Grain and class	Subclass
WHEAT:	
Hard Red Spring wheat	(A) Dark Northern Spring.
Grown principally in Minnesota, North Dakota, South Dakota, Montana, a little in western Kansas and western Nebraska, in restricted areas in the Mississippi Valley, and to a lesser degree in the intermountain and north Pacific coast areas.	(B) Northern Spring. (C) Red Spring.
Durum wheat	(A) Hard Amber Durum.
Grown principally in North Dakota, South Dakota, and Montana; also in small scattered areas on the Great Plains.	(B) Amber Durum. (C) Durum.
Red Durum wheat	
Grown principally in North Dakota, South Dakota, Minnesota, and Wyoming.	
Hard Red Winter wheat	(A) Dark Hard Winter.
Grown principally in States west of Mississippi River, and to a minor extent north of the Ohio River in Illinois and Indiana.	(B) Hard Winter. (C) Yellow Hard Winter.
Soft Red Winter wheat	(A) Red Winter.
Grown principally east of the Great Plains and south of Wisconsin. Scattered areas in Texas, Oklahoma, Kansas, and northwest Pacific Coast States.	(B) Western Red.
White wheat	(A) Hard White.
Grown principally in the Pacific Coast States, Michigan, northern Ohio, and New York. (White Club is grown principally in Pacific Coast States and in Utah and Idaho.)	(B) Soft White. (C) White Club. (D) Western White.
Mixed wheat (classified as Mixed wheat, Amber Mixed Durum, or Mixed Durum)	
CORN:	
Grown principally between Allegheny and Rocky Mountains.	
White corn.	
Yellow corn.	
Mixed corn.	
BARLEY:	
Barley (class I)	(A) Malting.
Grown east of the Rocky Mountains.	(B) Barley.
Western barley	
Grown west of the Great Plains region.	
Black barley	
Very small scattered production.	
Mixed barley	
OATS: [1]	
White oats	
Grown generally throughout the United States but mostly in the northern half.	
Red oats	
Grown mostly south of the Ohio River and in Texas, Oklahoma, and Kansas.	

[1] In addition to the standards for oats, standards have been established for Feed oats and Mixed Feed oats.

TABLE 2.—*Classes, subclasses, and areas of production*—Continued

Grain and class	Subclass
OATS—continued	
Gray oats	
Black oats	
Grown in scattered areas and the production is small.	
Mixed oats	
RYE:	
Grown principally in North Dakota, South Dakota, Minnesota, and eastward and north of Ohio River.	
GRAIN SORGHUMS:	
Grown principally in Texas, Oklahoma, Kansas, and California.	
White Grain sorghums	(A) White Kafir. (B) White Durra. (C) White Grain sorghums.
Yellow Grain sorghums	(A) Yellow Milo. (B) Yellow Grain sorghums.
Red Grain sorghums	(A) Red Kafir. (B) Red Grain sorghums.
Brown Grain sorghums	
Mixed Grain sorghums	
FLAXSEED:	
Grown principally in Minnesota, North Dakota, South Dakota, California, and in a few Midwestern States.	
SOYBEANS:	
Grown principally in the Corn Belt States	
Yellow soybeans.	
Green soybeans.	
Brown soybeans.	
Black soybeans.	
Mixed soybeans.	
MIXED GRAIN:	
Usually caused by mechanical mixtures but sometimes by planting or by volunteer growths.	

WHEAT CLASSES

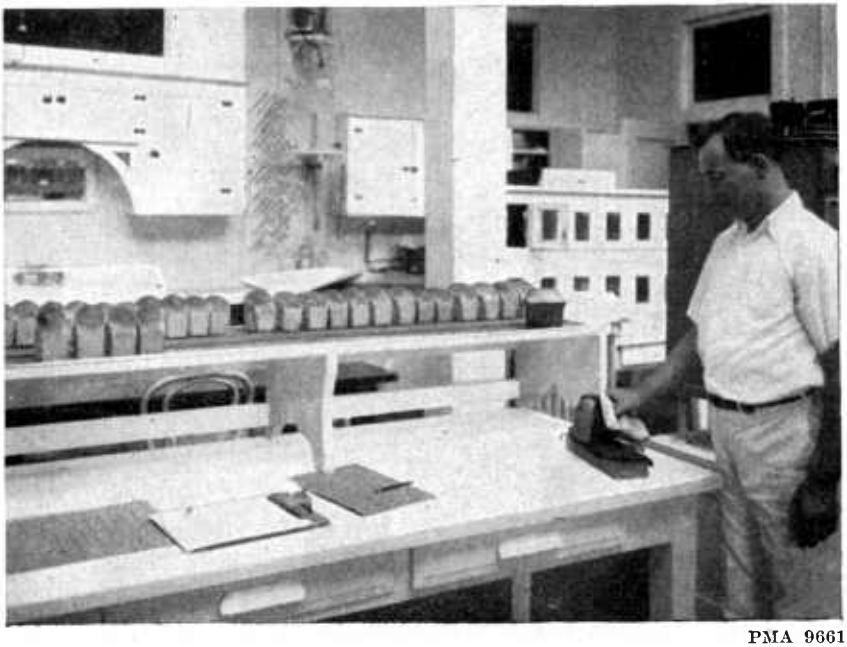
There are seven classes of wheat, namely: Class I, Hard Red Spring wheat; class II, Durum wheat; class III, Red Durum wheat; class IV, Hard Red Winter wheat; class V, Soft Red Winter wheat; class VI, White wheat; and class VII, mixed wheat. The official standards provide that wheat of any class, except Mixed wheat, may contain not over 10 percent of wheat of a different class or classes either singly or combined.

When grain inspection was first established the varieties of wheat were few compared with the number now prevailing in different localities. Earlier classification of wheat was comparatively simple. Flour mills, for example, did not then make the specialty flours that the baking trade now requires. Now grain standards must provide diverse classifications to meet variations in quality arising from numerous grain varieties and production conditions, as well as to meet the diverse requirements of grain users.

Hard Red Spring wheat and Hard Red Winter wheat are especially suited for the making of bread flour. These two wheats contain a large quantity of strong elastic gluten—an essential element in making a bread that meets the public favor in the United States.

Durum wheat is used for making semolina that is especially suited for the manufacture of macaroni, spaghetti, vermicelli, and other alimentary pastes. The principal use for Red Durum wheat is for poultry and stock feed.

Soft Red Winter and White wheat flours, both usually low in protein content, are specially suited for making pastry, crackers, biscuits and cakes, and similar products. The suitability of new wheat varieties for various purposes is determined by milling and baking tests (fig. 3).



PMA 9661

FIGURE 3.—Baking laboratory in the United States Department of Agriculture where wheat is tested experimentally to ascertain its value for bread or pastry making.

When gaining experience in recognizing the classes of commercial wheat, useful information may be had from variety names and time of planting. In places where proper classification of grain is difficult, it will be helpful to the beginner to obtain samples of the different classes of such grain from reliable sources that can vouch for the class. Department of Agriculture Circular 861 (*6*) lists the principal commercial varieties of wheat grown in the United States by classes and in the order of their estimated acreage in 1949.

Hard Red Spring: Mida, Thatcher, Rival, Ceres, Rescue, Marquis, Cadet, Pilot.

Durum: Mindum, Stewart, Carleton, Kubanka.

Red Durum: Pentad (D–5).

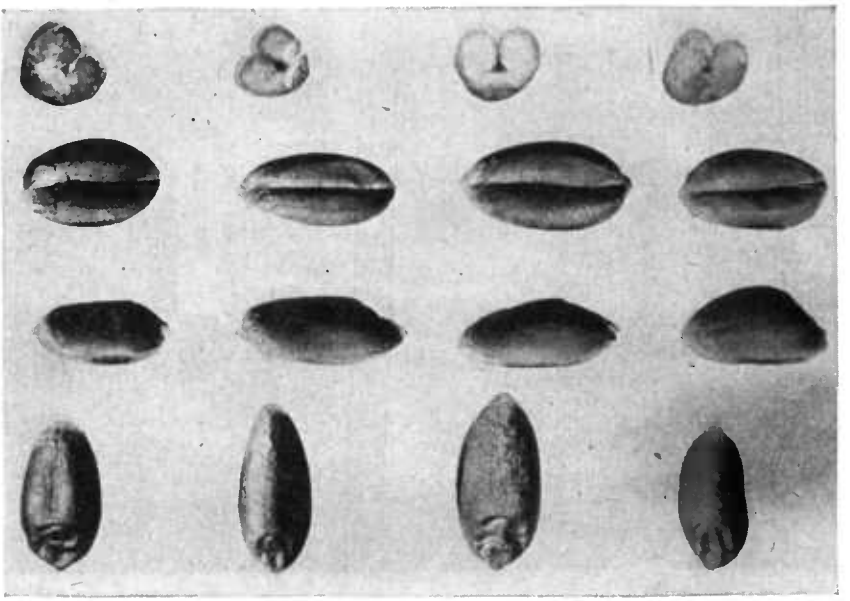
Hard Red Winter: Pawnee, Comanche, Triumph, Turkey, Wichita, Tenmarq, Westar, Blackhull, Cheyenne, Early Blackhull, Nebred, Red Chief, Yogo, Karmont.

Soft Red Winter: Thorne, Clarkan, Fairfield, Redhart, Vigo, Fultz, Fulcaster, Trumbull, Kawvale.

White: Yorkwin, Elgin, Federation, Baart, Rex, Goldcoin, Golden.

RED WHEATS

Hard Red Spring | **Hard Red Winter** | **Red Winter** | **Western Red**



PMA 11108

FIGURE 4.—Typical kernels in red wheats.

Kernel shapes that are characteristic of typical varieties in the several wheat classes are illustrated in figures 4 and 5. Note especially the relative size and shape of the germs, the appearance of the crease—whether open or tightly closed—and the outline of the kernel from both the side and top views.

There are some fairly constant characteristics in kernel shapes. For example, fully developed Durums are pointed sharply at the germ end and are widest back of the center of the kernel; most other wheats are widest near the germ. The crease in Durums is tightly closed and the seed coat over the germ is not as wrinkled as in other classes. The White class, of which two subclasses are shown in figure 5, is always yellowish white or tannish in color, the germs are large and the creases are wide open. The Soft Red Winter class, of which two subclasses are shown in figure 4, is generally characterized by soft texture, large

germs, open creases with rounded cheeks, and a red or yellowish red color.

The Hard Red Winter class (fig. 4) is represented by slender elliptical kernels, with a small germ, and tightly closed crease. When viewed from the side the bottom line of the kernel is relatively straight or slightly rocker in outline. The Hard Red Spring class (fig. 4) is represented by short kernels, usually hard and vitreous, and dark red in color. The germ is midsized, the crease deep and open, and the kernels have a prominent hump near the germ at one side of the center line of the back.

WHITE AND DURUM WHEATS

Western White **Soft White** **Durum** **Red Durum**

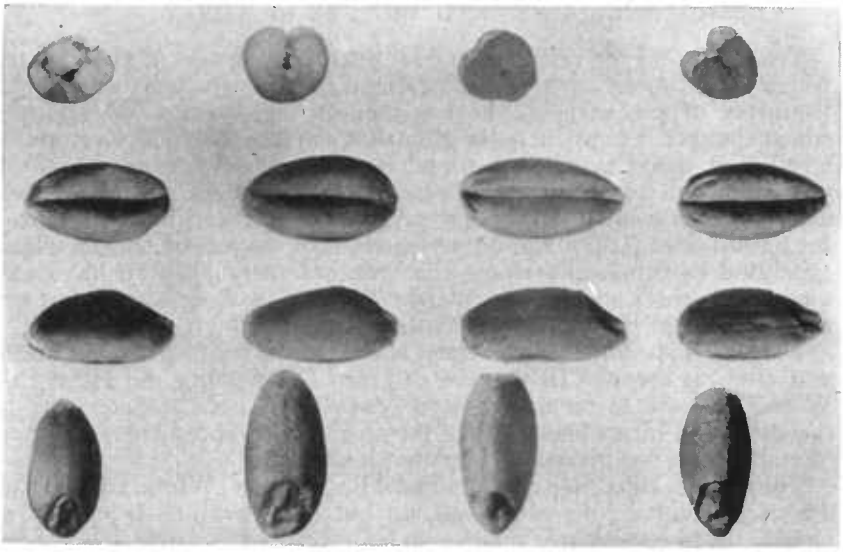


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FIGURE 5.—Typical kernels in white and durum wheats.

The foregoing brief general description of wheat classes does not apply in all respects to some of the more recent wheat varieties, resulting from crossing varieties of different classes. A competent inspector, in addition to knowing the general characteristics of wheat classes, must be familiar with certain variety characteristics. For example, Minturki, Michikof, Purkof, Iobred, Tenmarq, and Mosida are classified as Hard Red Winter wheats, yet in one or more respects they closely resemble wheats in other classes with which they are sometimes confused; Triplet and Kawvale are two Red Winter wheats of uncertain kernel characteristics and cannot always be distinguished from wheats in the Hard Winter class. To properly classify these wheats requires experience and study (*5*). The country grain dealer has the advantage of being in the producing area and has other means of identification than kernel characteristics. His difficulties should not

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be as great as they would be if he were handling grain in a large terminal market that draws grain from many different producing areas.

In the inspection procedure for determining class in wheat, the dockage is first removed (see p. 20 for method) and then a representative portion, of approximately 25 grams, is weighed. Any kernels that are distinctly of another class are separated from the predominating class, and the percentage of other classes, if any, is determined by weight. In addition to the limitation of 10 percent of wheats of other classes in all classes except Mixed wheat, there are special numerical grade limitations for wheat of other classes for all of the classes of wheat except Mixed and Red Durum. The experienced grader makes this latter determination with the same separation described in this paragraph.

SUBCLASSES AND TEXTURE IN WHEAT

Texture in wheat refers to the hardness or softness of the kernels, which qualities in turn are indications of the glutinous or starchy character of the kernels. In the case of the common wheats, any wheat that consists principally of hard kernels usually has a comparatively high quantity of protein and is well-adapted for bread-making purposes; and any wheat that consists principally of starchy kernels usually has a comparatively low-protein content and is best adapted for biscuit- and pastry-making purposes. In the case of Durum wheat (not Red Durum), any wheat that consists principally of hard and vitreous kernels of desired amber color is well adapted for the manufacture of high-quality semolina flour.

Texture is specified in the wheat standards in terms of "dark, hard, and vitreous kernels" in the case of Hard Red Spring and Hard Red Winter Wheats, in terms of "hard (not soft and chalky) kernels" in the case of White wheat, and in terms of "hard and vitreous kernels of amber color" in the case of Durum wheat.

The classes, Hard Red Spring, Hard Red Winter, White, and Durum are each divided into subclasses, all but one of which is wholly or largely based on texture.

The texture specifications in the standards for wheat provide a practical means for making estimates of the protein content in wheat when chemical tests are not available.

Hard Red Winter and Hard Red Spring subclasses.—A representative portion of approximately 25 grams of the dockage-free wheat is taken in determining subclass. In Hard Red Winter and in Hard Red Spring wheat the kernels are separated into dark, hard, and vitreous kernels and kernels that are not dark, hard, and vitreous. Any wheat kernels that are starchy or that have any starchy spots are not considered to be dark, hard, and vitreous. Bleached kernels otherwise hard and vitreous are considered as dark, hard, and vitreous kernels.

Durum subclasses.—To decide the subclass to which any lot of common Durum wheat belongs, a 25-gram portion of the dockage-free wheat is taken and analyzed for texture. In making the separation, any kernel that is not amber in color or any kernel that is starchy or that has a starchy spot on it is not considered to be "hard and vitreous and of amber color."

Red Durum.—There are no subclasses of Red Durum.

Amber Mixed Durum and Mixed Durum.—The standards for Mixed wheat provide for two special classifications known as Amber Mixed Durum and Mixed Durum. In both of these classifications there are special limitations for wheat other than Durum and especially for Red Durum, White, and Soft Red Winter wheats. These classifications provide for the superior mixtures of Durum with other classes of wheat.

Soft Red Winter subclasses.—Soft Red Winter wheat grown west of the Great Plains region is included in the subclass Western Red. All other Soft Red Winter wheats containing not in excess of 10 percent of Western Red are included in the subclass Red Winter.

White Wheat subclasses.—The class White wheat is divided into four subclasses (*12*). For determining the subclass of White wheat, the wheat in some cases is analyzed on the basis of texture and in other cases on the basis of variety characteristics.

The texture requirements for all the subclasses of the above classes of wheat, and the special limitations of certain variety types in subclasses, are given under the respective wheat classes in the Handbook of Official Grain Standards of the United States (*12*).

CORN CLASSES

Color in corn has become increasingly important in that many food products are made from this grain. In the manufacture of white corn meal, white corn grits, and corn flakes a very small percentage of kernels other than white will somewhat affect the color of the product. Yellow corn produces dark-colored corn flakes.

A mixture of white corn in yellow corn is not so objectionable as a mixture of the same proportion of yellow corn in white corn.

Classes of corn are based entirely upon color, namely, class I, Yellow corn; class II, White corn; and class III, Mixed corn. A slight tinge of red on otherwise yellow kernels does not affect their classification as Yellow corn, nor does a slight tinge of light straw color or of pink on kernels that are otherwise white affect their classification as White corn. Kernels that are deep red, blue, striped, or variegated in color are considered as being neither yellow nor white, and are therefore classified as Mixed corn. A mixture of more than 5 percent of kernels other than yellow in Yellow corn, and a mixture of more than 2 percent of kernels other than white in White corn, causes the corn to be classified as Mixed corn.

To make the test for color in the determination for class of corn, a representative portion of not less than 250 grams from which the cracked corn and foreign material has been separated, is used.

GRAIN SORGHUMS CLASSES AND SUBCLASSES

There are five classes of grain sorghums, all of which are based on color. Subclasses are provided for the classes White, Yellow, and Red. The most important of these subclasses are based on kernel types. The determinations for class and subclass are made on the basis of not less than a 25-gram portion 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 the small buckwheat sieve. If there appear to be mixtures of different grain

sorghums present, the above portion is separated into its component parts and the separations are weighed and the percentage of each computed.

OATS, SOYBEANS, AND BARLEY CLASSES

Oats are classified by color, as white, red, gray, black, or mixed, and soybeans as yellow, green, black, brown, and mixed. The black (glumes) barley (class II) is placed in a separate class from the white (glumes) barley. The latter, however, is classified by areas of production, Barley (class I) being that grown east of the Rocky Mountains and Western Barley (class III) being that grown west of the Great Plains region.

MALTING BARLEY SUBCLASS[3]

The specifications of the Malting Barley subclass limit the admixture of certain kinds of barley which are considered undesirable in barley intended for the malting process. Uniformity of size and good maturity are also desirable in malting barley. In the malting process the grain is germinated. Heat-damaged, blight-damaged, and skinned kernels decrease the germination and lower the quality of the malt. All of the specifications in the malting subclass are based on the sample after the removal of dockage, and in some cases after pearling. The full requirements for the subclasses are given in the Handbook of Official Grain Standards. The inspection procedure for making the determinations for the subclass Malting Barley are given below.

Sizing to determine Malting Barley.—The subclass Malting Barley may not contain more than 15 percent of barley or other matter that will pass through a 20-gage metal sieve with slotted perforations 0.076 (4⅞/64) of an inch wide by ¾ inch long. All sieves should be checked periodically for accuracy. (See discussion under sieves, p. 54.) In making the sieving test for Malting Barley, a representative portion of approximately one-fourth of the dockage-free barley is sieved with a hand sieve having perforations as described above. In sizing, the sieve is held level and so that the grain will move lengthwise of the slots. The barley is then moved 30 times (left to right and return) from side to side across the sieve in a steady manner. All barley and other material that passes through the slotted sieve is then weighed and the percentage is computed. If 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 insofar as this determination applies.

In trade terms the barley removed in this test is known as "undersized." This barley is not plump enough for malting barley.

When a mechanical divider is not available, the entire sample should be sieved—approximately 225-gram portions being sieved at a time.

Testing for mellow barley kernels.—The standards provide that Malting Barley shall contain 75 percent or more of mellow barley kernels which kernels are not semisteely as a whole. Mellowness has reference to starchiness. To determine the percentage of mellow barley in any parcel of barley of the class Barley, a portion of approximately 50 grams of the dockage-free barley should be placed in a pearling machine (fig. 6) and be subjected to the pearling process

[3] The discussion on the next three pages refers to the Malting subclass of "eastern" barley. The new special Malting grades for Hannchen and Hanna barley are discussed on page 62.

from 2 to 3 minutes. The pearled barley is then freed from dust and hulls by being sieved, after which the pearled kernels are weighed. All the white and gray-colored kernels that appear to be 10 or more percent starchy in texture are classified as mellow kernels. All pearled kernels ranging 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 (not the weight of the original sample before being pearled) the percentage of mellow kernels is computed.

Skinned and broken kernels in barley.—Skinned and broken kernels are objectionable in barley intended for malting purposes, as such kernels do not germinate satisfactorily. Broken kernels in barley are removed in preparing barley for malting, and they cause production losses in the pearling industry.

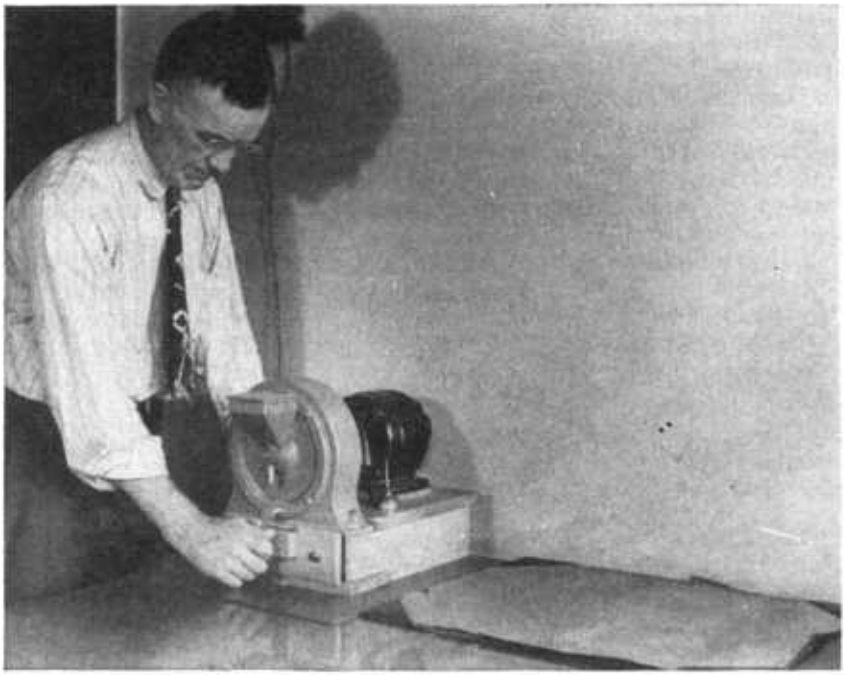

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FIGURE 6.—Barley pearler. This apparatus removes the hulls from barley kernels, exposing the endosperm for examination.

The breaking of wheat kernels and the skinning and breaking of barley kernels can be avoided to a large extent by careful threshing. The adjustment and speed of the cylinder, the number and setting of concaves, and the rate of feeding as well as other mechanical adjustments all affect the breaking or skinning of the threshed grain. The moisture in the unthreshed grain changes throughout the day, which makes necessary the adjustment of the machine at regular intervals to avoid damaging the barley kernels.

The standards for barley provide a 5-percent maximum limit of skinned and broken kernels in the subclass Malting Barley, but provide more lenient maximum grade limits for broken kernels only,

in the subclass Barley and in the other classes of barley. (See Handbook of Official Grain Standards (*12*).) A skinned kernel of barley is any kernel of barley that has at least one-third of the husk removed, or which has the husk loosened or removed over the germ. A broken kernel of barley is one that is broken, regardless of the extent or the size of the pieces. A portion of approximately 30 grams of the dockage-free barley is used for making this determination. In the grading of Malting Barley, the skinned and broken kernels, separated by hand from the sample being tested, are weighed and the percentage is computed.

Damaged barley.—Damaged barley consists of kernels and pieces of kernels of barley which are damaged or materially discolored by blight and/or mold, or which are heat-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 subclass Malting Barley. To determine the percentage of damaged barley a 30-gram portion of dockage-free barley is analyzed.

Unsuitable malting types.—The standards allow a tolerance of 5 percent of two-rowed 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 30 grams of dockage-free barley are analyzed and the percentage is computed.

Other subclass requirements for Malting Barley.—In addition to the foregoing requirements, barley in the Malting subclass must meet the requirements of the numerical grades Nos. 1 to 3, inclusive, of the class Barley. Bleached barley is excluded from the Malting Barley subclass.

RYE AND FLAXSEED

There is only one class of rye and one of flaxseed, and there are no subclasses.

DOCKAGE TESTING

The Federal standards for wheat, rye, barley, flaxseed, and grain sorghums provide for a determination of dockage. Dockage in wheat, rye, and barley may be defined as the foreign material in any of these grains which can be removed readily by appropriate sieves and cleaning devices, and undeveloped, shriveled, and small pieces of grain removed in properly separating the foreign material which cannot be recovered by proper rescreening or recleaning. Dockage in flaxseed, in addition to the sieved dockage, includes all foreign material remaining in the sample. In the case of grain sorghums the dockage consists only of the material that will pass through a prescribed sieve.

Some of the dockage material (such as other grains and wild oats) is valuable for feed but most of the dockage is worthless. Much of the material, like green weed seeds or finely broken grains or fine dust, contributes toward the grain heating or becoming musty, unless the grain is exceptionally dry.

A machine known as the Carter dockage tester (fig. 18) is used in the determination of dockage and in certain cases the cleaning oper-

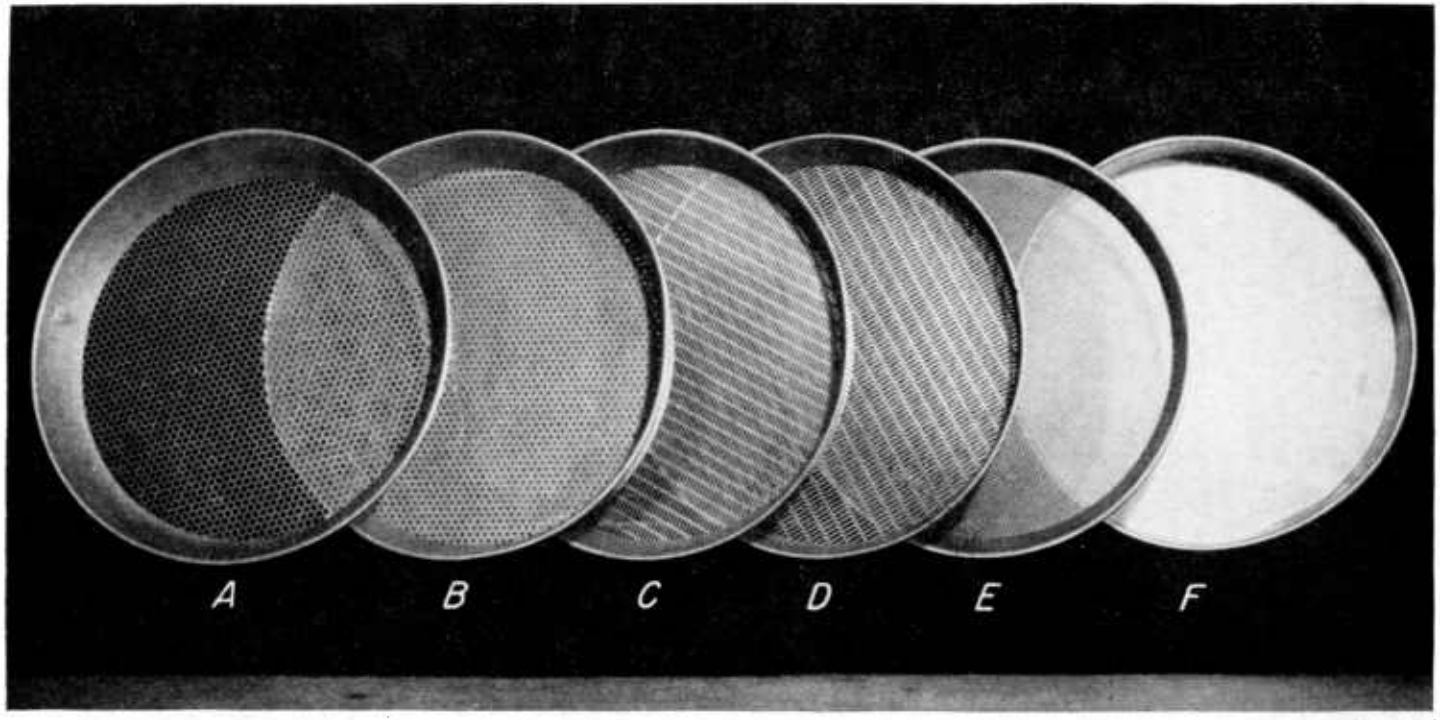

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FIGURE 7.—Some of the sieves used to supplement the dockage tester in determining dockage and for removing certain kinds of foreign material from grain; *A*, Corn sieve with round-hole perforations 12/64 inch in diameter; *B*, small buckwheat sieve with triangular perforations the inscribed circles of which are 5/64 inch in diameter; *C*, small chess sieve with slotted perforations 0.064 by 3/8 inch; *D*, large chess sieve with slotted perforations 0.070 by 1/2 inch; *E*, fine-seed sieve with round-hole perforations 1/12 inch in diameter; *F*, bottom pan.

ation of this machine is supplemented by the use of hand sieves (fig. 7). The Federal dockage tester or the Emerson dockage tester (fig. 19) is used where the Carter dockage tester is not available. These machines employ step-metal riddles for removing coarse dockage and sieves for removing weed seeds, dirt, and finely broken pieces of grain. Complete instructions for the use of these dockage machines may be obtained from any Federal grain inspection supervisor.

If none of the testers mentioned is available, approximate dockage determination can be made by hand sieves, using about 1⅛ quarts of grain. The hand sieves usually employed with the various grains are described on pages 54 to 57.

WHEAT AND RYE DOCKAGE DETERMINED WITH HAND SIEVES

If the sample contains coarse material, such as straw and sticks or oats and corn, this material may be removed, in part at least, by working the sample over the scalper sieve, known also as the 12/64-inch round-hole corn sieve. About one-fourth of the sample is placed on the sieve at a time. All threshed kernels of the grain being graded which remain on top of the scalper sieve should be picked out and returned to the cleaned sample. The coarse material is placed at one side for the time being and a further cleaning of the sample is accomplished with sieves of smaller-sized perforations. The 1/12-inch round-hole fine-seed sieve should be used except when wild buckwheat or other weed seeds of similar size and shape are present in a quantity in excess of 0.5 percent in wheat or in rye. For these exceptions the small buckwheat sieve is used.

About one-fourth of the sample is placed on it at a time and the sieve is shaken vigorously. The material that passes through the buckwheat sieve should be rescreened over the same sieve by placing not more than 50 grams of the material at one time on the sieve at the upper edge. Then, holding the sieve at an angle of 10° to 20°, the material is worked down over the sieve by a gentle side-sieving motion in such a way as to reclaim the grain. A second, or possibly a third, rescreening of the material that passes through the sieve may be necessary.

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 is considered as dockage and no further reclaiming is done. The dockage will consist of all coarse material except wheat (if wheat is being graded) that was removed by the scalper, 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.

Wheat containing chess.—When the original sample of wheat contains more than 0.5 percent of chess, quackgrass, or other weed seeds of similar size and shape, dockage should first be removed with the scalper sieve and the 1/12-inch round-hole sieve. The wheat so cleaned is screened further with the large chess hand sieve. A portion of approximately 250 grams of the sample is placed on the hand sieve and worked back and forth lengthwise of the slots until all of the remov-

able material has passed through the sieve. The operation is continued with similar-sized portions until the entire sample has been sieved.

The wheat that remains in the material passing through the hand chess sieve is then reclaimed in the following way: Using the hand sieve having $\frac{1}{12}$-inch round-hole perforations (fine-seed sieve) held at an angle of from 10° to 20°, the material is placed on the lower edge of the sieve and the lower edge of the sieve is struck with one hand in such a way 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. The operation is continued until all the separable dockage material has passed through the sieve.

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

In the case of rye containing chess, quackgrass, or similar seeds, no attempt is made to remove such material by the use of the chess sieves.

BARLEY DOCKAGE DETERMINED WITH HAND SIEVES

The dockage in barley consists of coarse material like straws, corn, large soybeans, and barley heads removed by a metal scalper riddle sieve with slotted perforations $\frac{9}{64}$ inch wide by $\frac{3}{4}$ inch long; also of fine material, such as weed seeds and dirt, removed by a 20-gage metal sieve with equilateral triangular perforations, the inscribed circles of which are $\frac{5}{64}$ inch in diameter (small buckwheat sieve). The dockage also contains undeveloped, shriveled, and small pieces of barley kernels removed in the screening process, which cannot be recovered by properly rescreening with the small buckwheat sieve.

The percentage of dockage is determined by weight. This means that a balance is needed for weighing the sample before it is cleaned and the dockage removed. If dockage content is less than 1 percent, it is disregarded, but if it is 1 percent or more, a statement to that effect is added to the grade, as "No. 1 Barley; dockage, 2 percent." When barley is sold by grade on the market, the seller ordinarily is not paid for dockage.

FLAXSEED DOCKAGE DETERMINATION

If no dockage tester is available, the removal of the dockage from flaxseed may be accomplished in two principal steps: (1) A mechanical separation is made with appropriate sieves and cleaning devices, and (2) a hand-picked separation of a portion of the mechanically cleaned flaxseed is made.

In making the mechanical separation enough flaxseed should be cleaned so that $1\frac{1}{8}$ quarts of the flaxseed will be available for determining the test weight per bushel.

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Wheat dockage sieves are not suitable for flaxseed dockage determinations; the sieves listed below are recommended for flaxseed.

Wire mesh—4 by 16 meshes to square inch.
Metal sieve—3/64- by 3/8-inch slotted perforations.
Metal sieve—0.064- by 3/8-inch slotted perforations (for large seeded flax).
Metal sieve—round-hole perforations 4½/64-inch diameter.

1. Cut out a representative sample of about 1,000 to 1,100 grams. Using one-fourth of this sample at a time, proceed as follows:
2. Run the sample through the wire mesh sieve to remove coarse dockage material.
3. Follow next with one of the slotted metal sieves to further remove coarse material.
4. Next run the sample over the round-hole sieve, rescreening the fine material removed over the same sieve to reclaim broken flaxseed.
5. Cut out 15 grams of sieved-clean flaxseed and remove all foreign material by hand.

Figuring dockage percentage.—(*a*) Determine percentage of dockage removed by sieving based on weight of the flaxseed, including the dockage.

(*b*) Subtract this percentage from 100 percent to find the correction factor for the hand-picked dockage.

(*c*) Determine the percentage of dockage in the hand-picked portion based on the sieved-clean grain and multiply this percentage by the correction factor.

(*d*) Add this corrected dockage percentage to the dockage percentage obtained by sieving to find the actual dockage.

Example:
(*a*) 1,000 grams of the original sample contains 100 grams of dockage or 10 percent.
(*b*) 100 percent—10 percent=90 percent (correction factor).
(*c*) 15 grams hand-picked contains 0.3 gram dockage or 2 percent. 2 percent × 90 percent (correction factor)=1.8 percent.
(*d*) Entire dockage=10 percent+1.8 percent, or 11.8 percent (11 percent assessed dockage).

GRAIN SORGHUMS DOCKAGE DETERMINATION WITH HAND SIEVES

Sieving determinations for dockage and for total cracked kernels, foreign material, and other grains in grain sorghums are made concurrently by grain inspectors. They are best accomplished by using the Carter, the Federal, or the Emerson dockage tester. However, the determination for dockage may be done by hand sieves and the determination for total cracked kernels, foreign material, and other grains may be done by the joint use of hand sieves and hand picking when dockage testers are not available.

When hand sieves are used for determining dockage in grain sorghums, the dockage consists of all that material that will pass through a hand sieve perforated with round holes 2½/64 inch in diameter. A representative portion of approximately 1⅛ quarts of the original sample is used for the hand-sieving operation. The hand sieve should be shaken vigorously with about one-fourth of the sample on the sieve at one time.

TEST WEIGHT PER BUSHEL

For many years plumpness has been considered an important characteristic of good grain. This quality is indicated in a general way by the test weight per bushel of the grain and is expressed in terms of pounds per measured (struck) Winchester bushel. Test weight per bushel is an important index of the pounds of flour that may be milled from a bushel of wheat, the largest flour yields generally being obtained from wheat of high test weight per bushel and relatively low yields of flour from wheat of relatively low test weight per bushel. For this reason millers prefer wheat of high test-weight-per-bushel quality, and premiums are usually paid for such wheat.

The equipment used by inspectors in making test-weight-per-bushel determinations is shown in figure 8. Detailed instructions for making this test are given in Department Bulletin No. 1065 (*4*).

PMA 1207

FIGURE 8.—Determining the test weight per bushel of grain in a grain inspection laboratory.

To determine the test weight per bushel of any grain approximately 1⅛ quarts of grain should be used. When this test is made with wheat, rye, or barley, the dockage must be removed before the test-weight-per-bushel determination is made. With corn, oats, and soybeans, for which there is no dockage provision, and with grain sorghums, the original sample of each of these grains inclusive of foreign material is used for making the test-weight-per-bushel determination. For flaxseed the test-weight determination is made after the removal of that part of the dockage which can be removed readily by the use of appropriate sieves and cleaning devices.

In making the weight-per-bushel test, the 1-quart bucket of the testing device is placed beneath a funneled hopper having a capacity of approximately 1⅛ quarts of grain. In the bottom of this hopper there should be an opening 1¼ inches in diameter. The bottom of the hopper must be placed 2 inches above the top of the bucket. The grain from the hopper is allowed to pour into the bucket until it overflows. Without moving or jarring the heaped bucket, the grain is leveled off with a special, smooth, round-edge stick in three zigzag strokes (fig. 8). The scale beam of the test-weight-per-bushel apparatus should never be used to level off the grain because the constant wearing effect on the beam and bucket will eventually affect the accuracy and because the square-edge beam has a tendency to hollow out the surface of the grain in the bucket, which will cause a lower test-weight-per-bushel reading than does the official method.

SHRUNKEN AND BROKEN KERNELS IN WHEAT

There is a serious objection to mixtures of shrunken and broken kernels with wheat of high test weight because the shrunken kernels adversely affect the flour yield. The official standards for wheat provide limitations in the top three grades for shrunken and broken kernels in the dockage-free grain. Although shrunken kernels may be found in all classes of wheat, Hard Amber Durum is probably the class most subject to broken kernels because of its extreme hardness.

The standards provide for a 7-percent limitation on shrunken and/or broken kernels in the top grade for each class of wheat and a 10-percent limit in the third grade (No. 2 grade is the third grade in the class Hard Red Spring). This grading factor includes shrunken and/or broken kernels of grain and other matter that will pass through a 20-gage metal sieve with slotted perforations 0.064 inch wide by ⅜ inch long (small chess sieve). In addition to these limitations, the standards for Durum wheat and for Red Durum wheat limit not only the percentage of shrunken and/or broken material that will pass through the sieve, but also the broken kernels of grain of any size that remain on the sieve. For these two classes of wheat the percentage of the combined shrunken and/or broken kernels that pass through the sieve and the broken kernels that stay on the sieve is limited to 10 percent in grades 1 and 2 and to 15 percent in grade 3. In all classes of wheat other than Durum and Red Durum, the limitations regarding shrunken and/or broken kernels apply only to the material that will pass through the sieve.

For all wheats except Durum and Red Durum the sieving is performed by placing approximately 250 grams of the dockage-free wheat on the small chess sieve, held level, and shaking the wheat 30

times (left to right and return) from side to side across the sieve in a steady manner and so that the grain moves lengthwise of the slots. For wheat of the Durum and Red Durum classes 50 grams of the dockage-free sample are sieved as just described and this operation is supplemented by hand-picking the broken kernels from the grain remaining on the sieve.

SMALL AND SHRUNKEN KERNELS IN RYE

There are limitations for what is known as "thin" rye in the higher numerical grades for rye. This determination is discussed under the subject Plump Rye on page 44.

MOISTURE TESTING

Dryness has always been a much-sought-after quality in grain. Any grain that contains moisture in excess of its normal air-dry condition is nearly always unsafe for storage, especially if the grain is stored at a high temperature. Threshing and combining operations for small grains should not start until the moisture content of the grain is 14 percent or less, for flaxseed it should not start until the moisture content is 11 percent or less, and for soybeans until the moisture content is 13 percent or less.

Wheat that contains more than approximately 14 percent of moisture often will spoil during storage or transportation, and it may spoil even with a lower moisture content in warm climates or under improper storage conditions. Damp grain cannot be satisfactorily milled for either flour or feed. Damp flour and damp feed will not long remain cool and sweet in storage.

The water oven is specified in the official grain standards as the official tester for determining the percentage of moisture in corn, and the air oven is specified as the official tester for determining the moisture content in all of the other grains. In practice, however, the moisture content of any grain may be found by any device and method for ascertaining the percentage of moisture that will give results equivalent to those obtained by the water- or air-oven tests. Two types of moisture testers in use give quicker results than can be obtained by either oven test.

ELECTRIC MOISTURE METER

One of the rapid testers is an electric moisture meter (fig. 9). It is used by all Federal grain supervisors and also by a large majority of the licensed grain inspectors throughout the United States. To make a moisture test with this apparatus not less than 150 grams of "small grain" or 250 grams of corn are passed between two roller electrodes. The meter measures the electrical resistance of the grain as it passes between these electrodes. Tables and complete instructions for converting the electrical resistances into terms of percentages of moisture are given in the latest revised edition of the Handbook of Instructions for the Installation and Operation of the Tag-Heppenstall Moisture Meter.[4]

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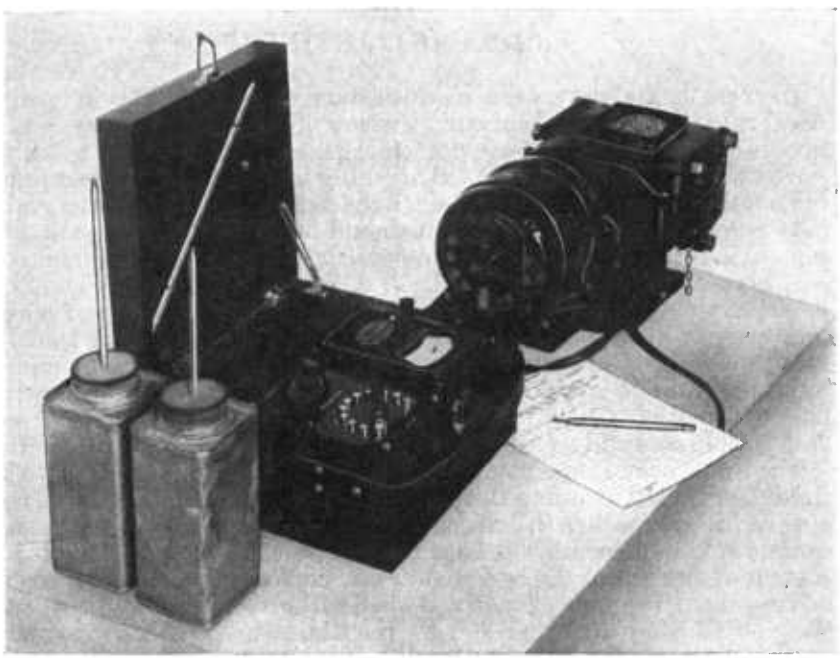
[4] United States Department of Agriculture, Handbook of Instructions for the Installation and Operation of the Tag-Heppenstall Moisture Meter (revised), USGSA—MBI–1. 93 pp., illus. 1938. [Processed.]

BROWN-DUVEL MOISTURE TESTER

The other type of rapid tester is the Brown-Duvel moisture tester (figs. 10 and 11). To determine the moisture content of grain with this tester, 100 grams of grain are mixed with 150 cubic centimeters of suitable engine oil in a distillation flask. Heat is then applied and the water is distilled into a graduated cylinder to determine the percentage quantity of moisture in the grain. For further details regarding the operation of this tester, the reader should refer to a copy of Department Bulletin No. 1375, revised, with mimeographed supplements Nos. 1 and 2 (*7*).



PMA 99570

FIGURE 9.—Electric moisture meter used for determining the moisture content of grain.

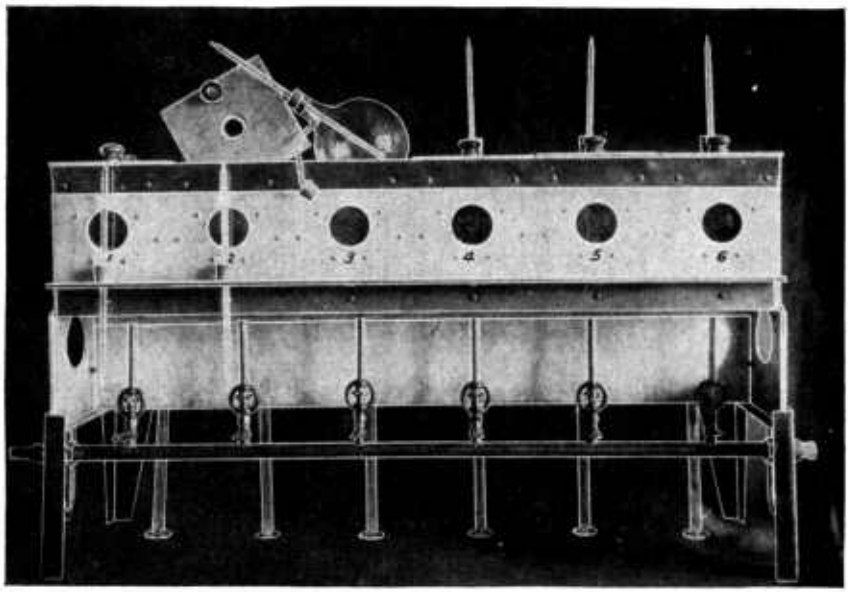
DAMAGED KERNELS

Damaged kernels are objectionable in grain. Soundness is a quality of considerable importance in evaluating grain for commercial use. The official grain standards for most grains permit only a small percentage of damaged kernels in the No. 1 grades, with increasing percentages of damaged kernels tolerated in each successive grade below No. 1. In the case of oats and barley the standards require a high percentage of sound kernels in the No. 1 grade.

Damage to kernels may be divided into types—field damage and storage damage. In turn, field damage may be subdivided into two kinds—preventable and nonpreventable. Frost damage, and such fungus damage as scab and cobrot, may be considered practically beyond the control of the grower, although much of the damage caused

by such fungus diseases as scab and cobrot may be reduced by crop rotation and seed treatment. On the other hand, grade loss from sprouted grain and stack-stained, ground-damaged, and weather- damaged kernels, and damage resulting from such fungus diseases as smut are more or less preventable.

Storage-damaged grain includes heat-damaged, weevil-damaged, and moldy grain. Damage caused in storage usually is preventable because it all takes place in the storage bins which are under the control of the operator of the storage facilities. Ventilation or artificial drying of high-moisture grain, and fumigation are the usual means for



PMA 9910

FIGURE 10.—Six-compartment Brown-Duvel moisture tester.

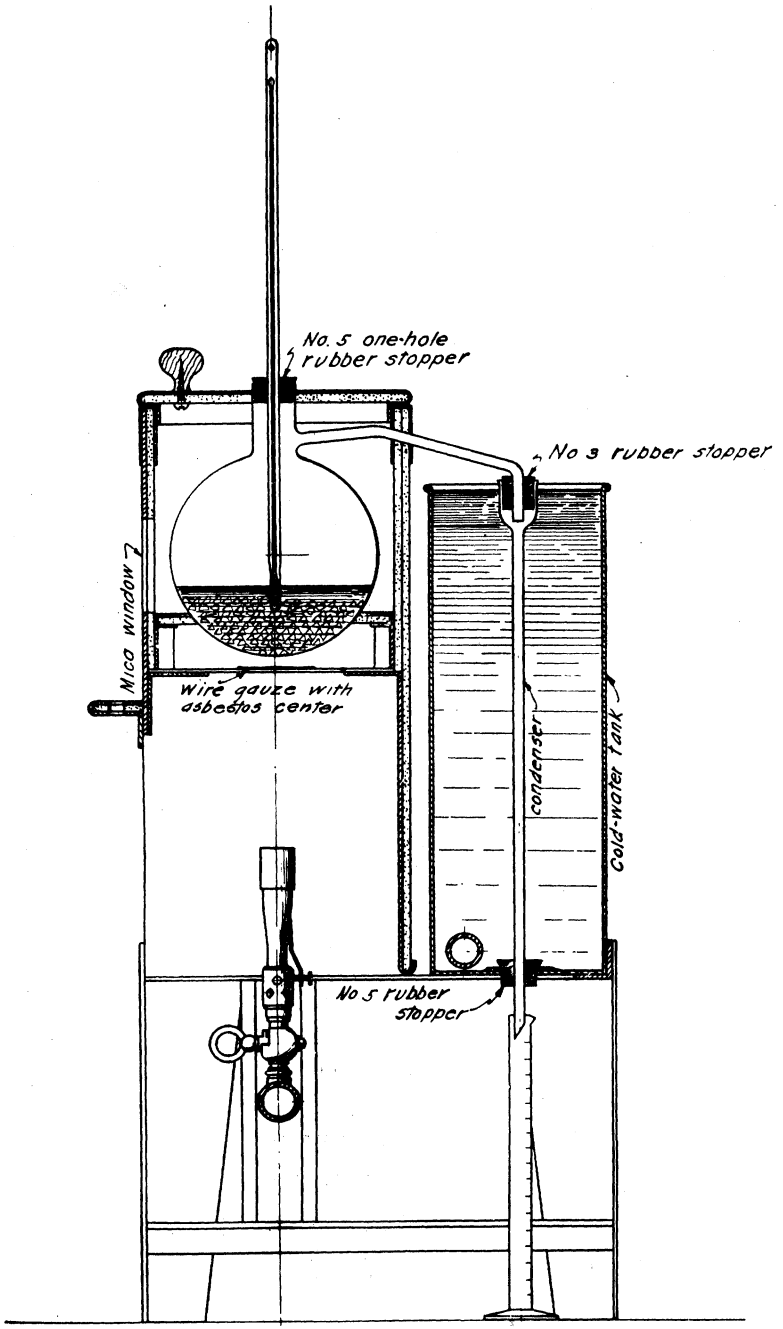
preventing damage in storage. Ordinarily more grain is damaged during storage than from all sources of damage to grain in the field.

The official interpretations of damaged kernels in grain when grain is being inspected and graded are conveyed to grain inspectors by means of type samples and by review by Federal grain supervisors of individual samples containing damaged kernels. The following descriptions of damaged kernels in wheat, corn, soybeans, and flaxseed have been condensed from the Grain Inspectors' Manual.[5]

WHEAT KERNEL DAMAGE

Damaged kernels shall be defined as 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.

[5] See footnote 2, p. 5.



PMA 10608

FIGURE 11.—Sectional view of Brown-Duvel moisture tester, showing the parts connected for use. Distillation flask is in position ⅜ inch above the wire gauze.

The following interpretations of damaged kernels apply to kernels and pieces of kernels of wheat and "other grains" that may be found in wheat.

Basis of determination.—These determinations are made on a representative portion of not less than 50 grams cut from the dockage-free wheat. "Damaged kernels" and "heat-damaged kernels" include damaged kernels and heat-damaged kernels, respectively, of wheat and other grains.

Frosted kernels.—Frosted kernels which are green or are discolored black or brown; or which have frost blisters extending around the back of the kernels and into the crease; or which have the bran coat partially flaked off; or which have a distinctly waxlike or candied appearance, are damaged kernels.

Kernels of good healthy color and otherwise sound that have a slight bran frost are classified as sound kernels.

Weevil or insect-bored kernels.—Kernels which have been bored by insects are damaged kernels.

Kernels that are otherwise sound but which are only slightly eaten by insects or from which the germ has been removed by insects, are classified as sound kernels.

Sprouted kernels.—Kernels which have the germ end broken open from germination, and kernels which have sprouted, including the kernels from which the sprouts have been broken off, are damaged kernels.

Blighted and scabby kernels.—Kernels that are affected by scab to the extent that the bran coat is broken open and show evidence of mold, or other diseased or damaged condition; kernels that have a dull, lifeless, and chalky appearance (so-called tombstone) as a result of disease; and also such kernels that have a moldy appearance of the germ or that have mold in the crease of the kernel; kernels that are affected by black-tip fungus to the extent that the fungus growth extends over the germ and into the crease of the kernel; kernels that are materially affected by white, pink, gray, black, or green mold; and kernels that are slightly heat-damaged as a result of incipient fermentation but which are not materially discolored, are damaged kernels.

Sick wheat.—A term applied to a type of storage damage usually associated with brown discolored germs, evidence of dead deteriorated germs, and of other damage to the kernel. Bulk samples of "sick" wheat usually have a dank off-odor.

Green kernels.—Kernels that are green in color are damaged kernels.

Other damaged kernels.—Kernels which are materially damaged from causes other than those listed are damaged kernels.

Weather-bleached kernels that are otherwise sound, and immature kernels that are discolored pink by hot winds but are without evidence of mold or other damage, are classified as sound kernels.

Heat-damaged kernels.—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, are heat-damaged kernels.

Effect of damaged wheat on flour quality.—The different kinds of damaged wheat kernels affect the milling and baking quality of the flour in different ways.

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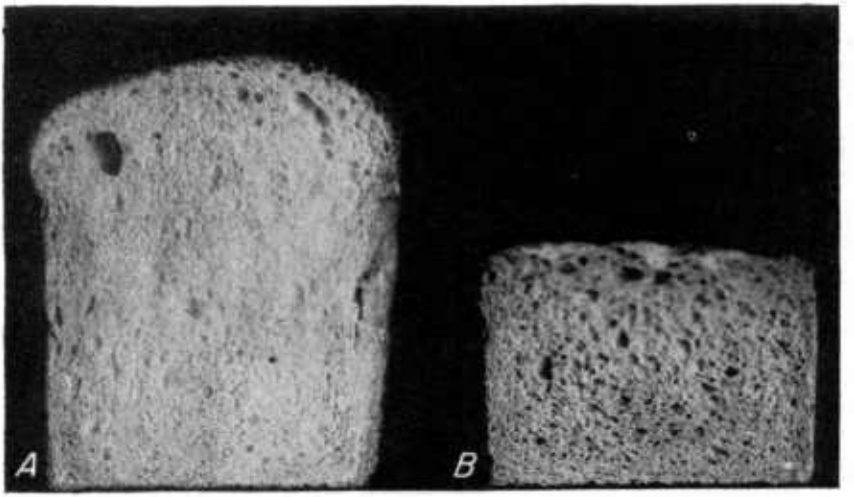
Frosted wheat, when the entire seed coat is badly affected, produces a flour of poor dough quality and is unsatisfactory for the production of good bread.

Heat damage in wheat is perhaps more objectionable than any other, because wheat so injured produces a flour poor in color and of unsatisfactory bread-making properties. Bread from such flour is small in volume, the crumb is discolored, the texture is very poor, and the bread has an offensive odor and usually tastes bad (fig. 12).

Heat damage in its early stages affects, among other things, the bran or the pericarp protective covering of the kernels. Such damaged kernels are commonly referred to as skin-burnt and possess unsatisfactory milling and baking properties. Similarly, stack-stain or header damage, caused from stacking grain that is not fully ripened and consequently is high in moisture content, produces flour of inferior bread-making qualities.



PMA 1065

FIGURE 12.—*A*, Loaf of bread made from flour milled from sound wheat; *B*, loaf of bread made from flour milled from wheat that contained a mixture of heat-damaged grain. Heat-damaged wheat makes poor bread.

Moldy wheat is often caused by storing damp wheat under unfavorable conditions. Such wheat usually develops a musty odor that will ultimately be transmitted to the products made from the flour.

CORN KERNEL DAMAGE

Damaged kernels are defined as kernels and pieces of kernels of corn which are heat-damaged, sprouted, frosted, badly ground-damaged, badly weather-damaged, or otherwise materially damaged.

In general, a kernel of corn is considered to be damaged for inspection and grading purposes only when the damage is distinctly apparent and of such character as ordinarily to be recognized as damaged for commercial purposes.

Basis of determination.—These determinations are made on a representative portion of approximately 250 grams cut from the sample after the removal of cracked corn and foreign material.

Blue-eye mold.—A kernel of corn, the germ of which is affected with blue-eye mold, is a damaged kernel.

Damaged germ.—A kernel of corn having a damaged germ is a damaged kernel.

Weevil-bored kernels.—(1) Kernels which bear evidence of boring or tunneling indicating the presence within the kernels of insects, insect webbing, or insect refuse; and (2) kernels in which noticeable weevil-bored holes have been eaten and in which webbing or weevil refuse still remain, are damaged kernels.

NOTE.—Kernels which have been partially eaten by insects or rodents but which are entirely free from refuse, webbing, or insects or other forms of damage are not damaged.

Slight surface mold.—Kernels of corn having surface mold growths which have not penetrated the kernels sufficiently to injure them shall be considered as sound kernels, provided the kernels are otherwise sound.

Silk-cut.—So-called "silk-cut" kernels not otherwise damaged shall be considered as sound kernels.

Heat-damage.—Kernels of corn which have been materially discolored and damaged by external heat or as the result of heating caused by fermentation, shall be considered as heat-damaged kernels.

Slight discoloration by heat.—Kernels of corn which have been damaged by heat, but are not distinctly discolored, shall be considered as damaged kernels, but not as heat-damaged kernels.

FLAXSEED KERNEL DAMAGE

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.

The standards provide that flaxseed which contains fire-damaged flaxseed shall be graded Sample Grade.

Basis of determinations.—These determinations are made on a representative portion of not less than 20 grams cut from the mechanically cleaned sample.

Damaged-seed characteristics.—Damaged seeds of flaxseed usually are characterized by decided discolorations, such as the white, dark brown, or black discolorations caused by disease or by a moldy, scabby, or dead appearance.

Very thin whitish paperlike seeds of flaxseed known as fly's wings are considered as damaged.

NOTE.—Green seeds of flaxseed are not to be considered as damaged because of greenness alone.

Fire-damaged flaxseed is characterized by a charred and dead, black appearance.

SOYBEAN KERNEL DAMAGE

Damaged kernels shall be kernels and pieces of kernels of soybeans and other grains which are heat-damaged, sprouted, frosted, badly ground-damaged, or otherwise materially damaged.

Basis of determination.—This determination is made on a representative portion of approximately 125 grams of the sample when free of that portion of foreign material removed by the $^{8}/_{64}$ round-hole sieve.

Damage must be distinct.—A soybean or other grain is damaged for inspection and grading purposes only when the damage is distinctly apparent and of such character as to be recognized as damaged for commercial purposes.

Frost damage.—Frosted soybeans which are discolored in cross section to an intense green or to an amber or greenish-brown color, and frosted soybeans which have a glassy, waxlike appearance, are considered as damaged.

Immature damage.—A soybean that is immature from any cause is considered as damaged when a cross section of it shows an intense green color or when it is green in color and of a mealy or chalky consistency.

Heat damage.—A soybean or piece of soybean which has been damaged by heat to the extent that a cross section of it shows a brown or black color is considered as damaged. A kernel or piece of kernel of other grains which has been materially discolored and damaged by heat is considered as damaged. There are no separate heat-damage limitations in the soybean grades. Heat-damaged beans are included with other damaged soybeans.

Insect-damaged kernels.—Soybeans, pieces of soybeans, and kernels and pieces of kernels of other grains, which contain insects, insect webbing, or insect refuse, are considered as damaged.

NOTE.—Soybeans, pieces of soybeans, and kernels and pieces of kernels of other grains, which are otherwise sound, and which have been partially eaten by insects but are free from insects, insect webbing, and insect refuse, are not considered as damaged.

Sprout and other damage.—Sprouted soybeans and soybeans which are materially damaged from causes other than those listed are considered as damaged.

Stained and mottled.—Soybeans which are stained or mottled on the surface or seed coat by weather and/or disease, but which are not damaged or discolored internally or in cross section, are considered as sound.

Slight surface mold.—Soybeans having surface mold growths which have not penetrated the soybeans sufficiently to injure them shall be considered as sound, provided the soybeans are otherwise sound.

SOUND CULTIVATED OATS AND SOUND BARLEY

The Federal standards for oats specify a minimum percentage requirement of sound cultivated oats in each of the numerical grades for oats. The percentage of sound cultivated oats in any sample is 100 percent minus the sum of the percentages (if any) of wild oats, foreign material, all damaged oats, and all grains other than oats. The same general procedure applies to the determination of sound barley except that the determination for barley is made after the dockage has been removed. (See the definition for Sound Barley in the Handbook of Official Grain Standards (*12*).)

DAMAGED-KERNEL COMPUTATION

To determine the percentage of damaged kernels in any sample of grain, certain minimum quantities are taken of the various grains in accordance with the data in table 1. The percentage of heat-damaged kernels and the percentage of foreign material in samples of wheat, oats, rye, and barley may be determined at the same time and with the same portion of the sample that is used for determining damaged kernels. For determining total damaged kernels, heat-damaged kernels are included with all other kinds of damaged kernels but, except for soybeans and flaxseed, separate computations for heat-damaged kernels only must be made.

FOREIGN MATERIAL AND RELATED DETERMINATIONS

CORN: CRACKED CORN AND FOREIGN MATERIAL

Corn is usually free from material other than corn. Small broken pieces of corn are the principal ingredients in "cracked corn and foreign material." Cracked corn is sometimes caused by setting corn shellers too closely or by shelling the corn when it is too wet; but excessive quantities of cracked corn arise principally from the quick-drying practices that are sometimes used in the artificial drying of corn. High-moisture corn that has been dried very rapidly and with excessive heat is broken easily when it is handled by ordinary commercial practices through modern grain elevators.

If neither the Carter nor the Emerson dockage tester is available, a hand sieve, perforated with round holes 12/64 inch in diameter, may be used for determining cracked corn and foreign material, by sieving vigorously separate 1-pint portions of a 1⅛-quart sample. Any cobs and matter other than corn that do not pass through the sieve are removed by hand and added to the matter that passes through the sieve. The percentage of cracked corn and foreign material is then computed from the weight of the material removed and the weight of the original sample used for the test.

GRAIN SORGHUMS: TOTAL CRACKED KERNELS, FOREIGN MATERIAL, AND OTHER GRAINS

The "total cracked kernels, foreign material, and other grains" in dockage-free grain sorghums includes all the matter that will pass through the small buckwheat hand sieve when operated in the same way as the dockage sieve described in the paragraphs entitled "Grain Sorghums Dockage Determination with Hand Sieves," page 24. In addition to the material so removed this factor also includes all material except grain sorghums and nongrain sorghums that remains on the small buckwheat sieve after the screening is done. To complete the determination for this factor, therefore, not less than a 50-gram representative portion of grain is taken from the sieved grain remaining on the small buckwheat sieve and is hand-picked for foreign material and other grains. The precise methods for computing "total cracked kernels, foreign material, and other grains" in grain sorghums, used by grain inspectors, may be obtained from any Federal grain supervisor. (See example under flaxseed dockage, p. 24.)

OATS: FOREIGN MATERIAL

Foreign material in oats usually consists of small weed seeds that can be readily removed by sieves, and of straws, weed stems, and similar trash. Foreign matter is often detrimental because of its effect upon the products manufactured from the grain.

To determine the foreign material in oats a representative portion of at least 30 grams from the original sample is analyzed either by hand-picking or by a combination of sieving with the small buckwheat sieve and hand-picking. When the sieve is used, any oats that pass through the sieve are hand-picked and returned to the oats. Any foreign material that remains on the sieve is hand-picked and is added to the foreign material obtained by sieving. The total foreign material so obtained is then weighed, and the percentage thereof is computed on the basis of the portion of the sample used in making the test.

Wild oats in oats.—The percentage of wild oats in each numerical grade of oats is definitely limited. (See Handbook of Official Grain Standards (*12*).) The 30-gram portion described in the preceding paragraph may be used for determining the percentage of wild oats by hand-picking and weighing.

SOYBEANS: FOREIGN MATERIAL

The determination for foreign material is made on a representative portion of approximately 125 grams.

Inspectors clean soybean samples with a screen or sieve. The sieve has round holes 1/8 inch across. Dirt, pieces of soybeans, and other matter taken out with the sieve are known as fine, foreign material. Foreign material also includes corn and other grains, sticks, pods, weed stems, and large weed seeds, such as those of cockleburs, morning-glories, horsenettles, or groundcherries, which will not go through the sieve. Inspectors pick this coarse material off the sieve and add it to the material that went through the sieve. The combination of the fine material removed by the sieve and the coarse material that remained on the sieve makes up the foreign material.

SPLITS IN SOYBEANS

Split beans are objectionable in soybeans as they complicate cleaning and storage problems. The oil in the split beans also oxidizes more rapidly than in whole beans. Splits are defined as pieces of soybeans. The split beans that are damaged are classed as "splits" and also as damaged.

In the practical application of the grades, kernels with one-fourth or less of the bean broken off are not considered as split. The determination for splits is made on a representative portion of approximately 125 grams of the sample when free of the foreign material that passes through the 8/64-round-hole sieve.

A hand sieve with slotted perforations 8/64 or 9/64 or 10/64 by 3/4 inch may be used to facilitate the separation of splits from whole soybeans. The analysis must be completed by hand to see that no splits remain in the whole beans and that no whole beans remain in the splits separation. Fractions of 1 percent are disregarded in the recording of the percentage of splits.

WHEAT AND RYE: FOREIGN MATERIAL OTHER THAN DOCKAGE

The foreign matter that cannot be removed as dockage in wheat and rye is commonly referred to as "foreign material." In wheat and rye the foreign material that remains in the grain after the removal of dockage usually consists of the larger seeds of wild buckwheat, vetch, corncockle, kinghead, wild rose, chess, quackgrass, small kernels of barley, oat groats, and other seeds and grains similar in size to wheat or rye kernels. Milling and baking tests show that these impurities are objectionable.

Rye, when present in significant quantities in wheat, results in darkening the flour. The yield of flour made from wheat that contains rye is also reduced.

Rye and barley are objectionable in durum wheat because they cannot be entirely removed. Rye causes a darkening in the color of macaroni. Small portions of the barley hull pass into the flour and appear in the macaroni products.

Corncockle in wheat adversely affects the volume, color, and texture of the loaf and may reduce the percentage of water absorption in the flour. Particles of the outer coating of the cockle seeds frequently appear as black specks in the flour made from wheat that contains cockle.

Determining foreign material in wheat and rye.—For wheat, not less than 50 grams of dockage-free wheat are analyzed for determining the percentage of foreign material which includes all matter other than wheat, except smut balls, remaining in the wheat after the dockage has been removed. The portion of the sample that is used for this analysis may also be used for ascertaining the percentage of damaged kernels. A similar procedure is used for determining foreign material in rye.

Rye is the principal foreign matter other than dockage that is found in wheat, and wheat is the principal admixture of foreign material found in rye. This admixture of one milling grain with another is not as objectionable as a mixture of inseparable weed seeds or inert matter. In the wheat and rye grades there are special limits for this latter class of foreign material, known as "matter except other grains" (abbreviated MEOG) in the wheat grades, and known as "foreign matter other than wheat" in the rye grades. (See grade tables in Handbook of Official Grain Standards (*12*).)

GENERAL APPEARANCE AS A GRADE FACTOR

The official standards provide that slightly weathered oats and badly stained or materially weathered Feed oats and Mixed Feed oats shall not be graded higher than No. 3. Materially weathered soybeans and badly stained or materially weathered oats or barley, except Western Barley, shall not be graded higher than No. 4. Badly stained or materially weathered Western Barley is designated by the special grade designation "Stained."

Badly weathered grain sorghums are graded Sample grade. Appearance also governs the application of the special grades Bright, Discolored, and Stained, discussed further under the chapter on Special Grade Designations (p. 39).

SAMPLE GRADE AND DISTINCTLY LOW-QUALITY GRAIN

The grain standards provide a Sample grade in which is placed grain which does not meet the requirements of any of the higher numerical grades.

Any grain which is too damp for the "Tough" grade (see p. 47) is placed in Sample grade.

Not all Sample grade grain is of distinctly low quality, for grain may be Sample grade because of low test weight or excess foreign material content. The term "otherwise of distinctly low quality" is incorporated in the Sample grade definition to provide for occasional lots of grain which are obviously of distinctly low quality because of some factor not included in the written grade requirements. Examples are grain mixed with large stones, pieces of glass, pieces of concrete, or wreckage too large to enter the probe. Rodent excreta mixed in grain is another example. Grains treated with insecticides or fungicides which leave a residue on the grain fall into this classification.

Extreme care should be used in handling chemically treated seeds in the same plant with food grains.

STONES AND CINDERS

Stones and cinders are objectionable in grain intended for processing or for feeding. However, if the stones and cinders are removed by the sieving process used in determining dockage, they are disregarded and only the "inseparable stones and cinders" remaining in the work sample (1⅛ to 1¼ quarts) are considered. Thus in the case of wheat, barley, rye, and grain sorghums, the determination for stones and cinders is made on the sieved (dockage-free) sample. In the case of corn, oats, and soybeans, 1⅛ to 1¼ quarts of the original sample is used.

When the number of stones and cinders exceed seven in the case of wheat or rye, the grain is graded Sample grade.

With corn, oats, barley, grain sorghums, and soybeans the number of stones and cinders must exceed seven and the total weight of stones and cinders must exceed 0.2 percent before the Sample grade is applied.

WILD BROMEGRASS SEEDS

Wild bromegrass seeds in excessive numbers is cause for applying the Sample grade in oats and in western barley. The wild bromegrass seeds must be unhulled and by number exceed 10 in 1⅛ to 1¼ quarts of the original sample in oats, and the same number in the dockage-free sample in barley.

ODORS IN GRAIN

The official grain standards provide that musty or sour grain, or grain that has any commercially objectionable foreign odor, except of smut or garlic, shall be graded Sample grade. Musty or sour odors in grain are the result of mold growth or of fermentation and heating, and are indexes of deterioration in grain quality that materially lowers its value to grain users. Commercially objectionable foreign odors in grain result from the absorption by grain in railroad cars and other containers of residual odors from commodities like hides, oil, and fertilizer previously stored in such containers. The principal reasons for including such grain in Sample grade are that in case of wheat or rye the odor usually is carried into the flour and in case of the feed grains the odor adversely affects the palatability and in extreme cases the actual feed value.

When grain is being tested for these odors the original sample should be carefully examined for odor before there is any cleaning or sieving of the grain and before the grain has been exposed to the air for any considerable length of time. If it is impracticable to make this test at the time of sampling or immediately after the sample arrives in the laboratory, a representative portion of the sample should be placed in an airtight container until conditions permit the test to be made properly.

TEMPERATURE

When high temperatures develop in grain as the result of fermentation, such grain is "heating" or "hot" and is graded Sample grade. Heating or hot grain usually gives off a sour or musty odor which indi-

cates fermentation within the mass of grain. Care should be taken never to confuse grain that is heating or hot from fermentation with sound grain that becomes warm due to storage in bins, cars, or other containers during hot weather.

GRAIN UNFIT FOR MIXING

Sometimes grain becomes so badly damaged and out of condition as to be considered unfit, under the food laws, for mixing with grain of a higher grade. Its quality is so low as to constitute an adulterant. Such grain may or may not be "unfit for human consumption."

The Department of Agriculture through the Grain Branch of the Production and Marketing Administration maintains a service at Chicago through which opinions are rendered as to whether or not a lot of grain is unfit for mixing with grain of a higher grade. By sending a sample of the grain in question to the grain inspection supervisor in his district (see p. 60 for address), any country shipper or farmer may obtain this service.

SPECIAL GRADE DESIGNATIONS

Because the commercial value of grain is not always reflected by its numerical grade alone, the official grain standards provide for special-grade designations for each of the grains excepting flaxseed. The special grades designate the condition of the grain due to weathering, excess moisture, artificial treatment such as chemical bleaching or mechanical scouring; or the special grade denotes the presence of live insects injurious to stored grain, or the presence of garlic, ergot, or smut. Provision is also made for special grades to designate quality based on test weight per bushel, general appearance of the grain, and kernel size. Illustrations of special grades are: Extra Heavy oats, Bright Yellow grain sorghums, Plump rye, and the Thin special grade in the standards for oats.

There are six special grades that have to do with the classification of the grain on the basis of variety; they are the Flint, and Flint and Dent, special grades in corn; the Two-rowed grade in barley; the designation placing the Columbia variety of oats in the Special Red oats grade, and the Malting special grades for Western barley of the Hannchen or Hanna types.

Special-grade terms that denote grain of superior quality, such as "Heavy," and "Bright," appear in the complete grade designation immediately following the numerical grade, as: No. 1 Extra Heavy Bright White oats. Special grades denoting adverse qualities are added to the grade designation following the class or subclass name, as: No. 1 Amber Durum, Tough, Smutty, Ergoty, Dockage 2.0 percent.

A list of the special grades and the standards in which they occur is given in table 3. The grains that are graded on a dockage system are indicated at the bottom of the table. As provided in the basis of grade determinations in the official standards, the analysis of the sample for the purpose of applying a special grade is based upon the sample as a whole, or upon the grain when free from dockage or in the case of corn upon the grain after the removal of cracked corn and foreign material. The three bases of determinations are indicated respectively in the table by the letters W, D, and F.

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TABLE 3.—*Special grade designations in the standards for the various grains*

Special grade designation	Grain and basis of determination [1]									
	Wheat	Corn	Barley	Oats	Feed oats and mixed feed oats	Rye	Grain sorghums	Flaxseed	Soybeans	Mixed grain
Re appearance:										
Bleached			D	W	W					
Bright			[2] D	W			W			
Discolored							W			
Stained			[2] D							
Treated	D									W
Re garlic bulblets:										
Light Garlicky	W					W				
Garlicky	W		W	W		W			W	W
Re smut:										
Light Smutty	[3] D					[3] D				
Smutty	[3] D		D	W	W	[3] D	W			W
Smut dockage (optional method)	D									
Re test weight:										
Extra Heavy				W						
Heavy				W						
Medium Heavy				W						
Test weight of Western Barley			[2] D							
Re other factors:										
Blighted			D							W
Choice Malting Two-rowed Western Barley			[2] D							
Ergoty	D		D	W	W	D				W
Flint		F								
Flint and Dent		F								
Malting Two-rowed Western Barley			[2] D							
Plump						D				
Special Red				W						

Thin				W						
Tough	D		D	W	W	D				W
Two-rowed			D							
Weevily	W	W	W	W	W	W	W		W	W
Dockage system applied	W		W			W	W	W		

[1] W, the special grade is determined upon the grain as a whole. D, the special grade is determined upon the basis of the grain when free from dockage. F, the special grade is determined upon the basis of the grain after the removal of the cracked corn and foreign material.

[2] The special grade in barley applies to Western Barley only.

[3] The odor of smut is determined upon the grain as a whole.

BLIGHTED BARLEY

The damage commonly referred to as scab or blight in barley is caused by minute fungus parasites of several known kinds which attack barley. The blighted barley kernels are discolored black, pink, or reddish brown. Barley that is badly blight-infected is often light in test weight per bushel. For determining the percentage of blighted kernels in a sample of barley, a portion of not less than 30 grams of the dockage-free barley is analyzed. When more than 4 percent of the barley is blight-damaged, the word "blighted" is added to, and made a part of, the grade designation. Any barley in grade No. 1 of the class Barley or of the class Black Barley that does not come within the provisions of the special grade Blighted may contain not more than 2 percent of blight-damaged barley.

BRIGHT OATS

Oats of good natural color, excepting bleached oats, are graded as Bright. For this determination the whole sample is used, and as there is no mechanical test for this factor, the decision of whether or not the oats are Bright rests entirely upon the grader's judgment. In actual practice, licensed grain inspectors are guided in their decisions by instructions and types issued by the United States Department of Agriculture. For oats that are graded Bright the word "Bright" is added to, and made a part of, the grade designation, with the word "Bright" preceding the name of the class. An example of the use of this term is No. 1 Bright White oats.

BRIGHT GRAIN SORGHUMS AND BRIGHT WESTERN BARLEY

The special grade Bright is also provided for grain sorghums and for Western Barley. (See paragraph "General Appearance as a Grade Factor" on p. 37.)

DISCOLORED GRAIN SORGHUMS

Grain sorghums that are discolored but that are not badly weathered are graded as Discolored and the word "Discolored" is added to, and made a part of, the grade designation, as, for example, No. 2 White Kafir, Discolored. (Badly weathered grain sorghums are graded Sample grade.)

ERGOTY GRAIN

Ergot is a fungus disease that attacks cereal grains, principally rye and occasionally Durum wheat and barley.

Any dockage-free wheat, rye, or barley, as well as any oats, Feed oats, Mixed Feed oats, and Mixed Grain (with all of the foreign material included in the last four grains) which contains more than 0.3 percent of ergot is classified as Ergoty, and the word "Ergoty" must be added to, and made a part of, the grade designation.

Ergot is objectionable because it discolors the flour if milled with the grain. Ergot also contains poisonous compounds that may be injurious to man and animals; thus foods and millfeeds manufactured from ergoty grain are undesirable.

The regulations for the enforcement of the Federal Food, Drug, and Cosmetic Act provide that any flour or other manufactured cereal

product that contains more than 0.1 percent of ergot shall be considered to be adulterated. Consequently, as much as possible of the ergot should be removed from grain that contains ergot before the grain is converted into flour or feed.

Determining percentage of ergot in wheat, rye, or barley.—To determine the percentage of ergot in either wheat, rye, or barley, a representative portion of at least 250 grams should be taken from the dockage-free grain.

The ergot is picked out by hand and weighed, and the percentage of ergot is computed on the basis of the portion analyzed.

Determining percentage of ergot in oats, Feed oats, Mixed Feed oats, or Mixed Grain.—To determine the percentage of ergot in oats, Feed oats, Mixed Feed oats, or Mixed Grain, a representative portion of at least 250 grams should be taken from the original sample (all foreign material included). The ergot is picked out by hand and weighed, and the percentage of ergot is computed on the basis of the portion analyzed.

EXTRA HEAVY OATS (ALL CLASSES)

Any oats that have a test weight of 38 pounds or more per bushel are graded as Extra Heavy and this term is added to, and made a part of, the grade designation. An example of this special grade designation is No. 2 Extra Heavy White oats.

FLINT CORN

The greater part of the corn in commerce is the dent type, but recently some flint types of corn have been placed on the market. The official grain standards for corn define Flint corn as corn of any class that consists of 95 percent or more of corn of any of the flint varieties. An example of special grade designation for flint corn is No. 1 Yellow corn, Flint.

FLINT AND DENT CORN

Flint and Dent corn is defined in the standards as corn of any class which consists of a mixture of the flint and dent varieties and which contains more than 5 percent but less than 95 percent of corn of any of the flint varieties. An example of a special grade designation for such corn is No. 3 White corn, Flint and Dent.

To determine the percentage of flint corn in a sample, a representative portion of approximately 250 grams of the sample from which the cracked corn and foreign material has been previously removed should be analyzed for flint and dent kernels. The separation of the flint corn is then weighed and the percentage computed.

GARLICKY WHEAT

Wild garlic and onion bulblets are frequently found growing with Soft Red Winter wheat. The presence of wild garlic or onion bulblets frequently causes a substantial reduction in the price millers will pay for the grain. Wild garlic and onion bulblets in wheat are objectionable because they clog the rolls of the mill during the grinding process, thus reducing the efficiency of the milling machinery, and because flour made from garlicky wheat often is tainted with garlic

odor. For these reasons garlicky wheat usually is subject to price discounts.

Garlicky wheat is wheat that contains two or more green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets in 1,000 grams of wheat before the removal of dockage. Three dry garlic bulblets are considered equivalent to one green garlic bulblet. Not less than 1,000 grams of grain are used for making this determination.

1. In case there are two or more, but not more than six, green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets per 1,000 grams of wheat, the wheat is classified as "Light Garlicky," and this term is added to, and made a part of, the grade designation.

2. In case there are more than six green garlic bulblets or an equivalent quantity of dry or partly dry bulblets per 1,000 grams of wheat, the wheat is classified as "Garlicky" and this term is added to, and made a part of, the grade designation.

GARLICKY RYE, BARLEY, OATS, SOYBEANS, AND MIXED GRAIN

Special grades for garlicky rye, garlicky barley, garlicky oats, garlicky soybeans, and garlicky Mixed Grain apply to these grains when the garlic present exceeds the limitations provided in the garlicky definitions for such grain. (See Handbook of Official Grain Standards (*12*).)

HEAVY OATS (ALL CLASSES)

Any oats that have a test weight of 35 pounds or more per bushel but less than 38 pounds are graded as Heavy and this term is added to, and made a part of, the grade designation. An example of this special grade designation is No. 2 Heavy White oats.

HEAVY HARD RED SPRING WHEAT

The designation "Heavy" is not set up specifically as a special grade in the standards for Hard Red Spring wheat, but specifications concerning it are included in the tabulated parts of the standards. For any wheat of the subclasses Dark Northern Spring, Northern Spring, and Red Spring of the class Hard Red Spring which grades No. 1 and which has a test weight per bushel of 60 pounds or more, the word "Heavy" is added to the grade designation preceding the name of the subclass. An example of this grade is No. 1 Heavy Dark Northern Spring.

MEDIUM HEAVY OATS (ALL CLASSES)

Any oats of grades Nos. 3, 4, and Sample grade, which have a test weight per bushel of 30 pounds or more but less than 35 pounds, are graded Medium Heavy.

PLUMP RYE

To provide a special designation for rye which is relatively free of small and shrunken kernels and to restrict admixtures of shrunken kernels in rye of high test weight and grade, the rye standards provide for a "sizing" test. The material removed in the test is designated "rye and other matter that will pass through a metal sieve with rectangular perforations 0.064 inch wide by ⅜ inch long" (small

chess sieve). Such rye and other matter is generally referred to as "thin rye." If not more than 5 percent of such matter is present, the special grade Plump is added to the grade designation.

Furthermore, the rye in grade No. 1 may contain not more than 10 percent, in grade No. 2 not more than 15 percent, and in grade No. 3 not more than 25 percent of the previously described rye and other matter.

In inspection practice the test with the sieve is made on a representative portion of the sample consisting of one-fourth of the dockage-free rye that was used for the weight-per-bushel test. This portion may weigh about 250 grams. The portion of grain to be tested is sieved in the following manner:

Hold the sieve in both hands 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 from left to right to complete one operation. Repeat the operation 30 times. The rye remaining in the slots should be returned to the portion of the sample that remains on top of the sieve.

Weigh the material removed by the sieve and determine the percentage.

SMUTTY WHEAT

Any wheat which before the removal of dockage has an unmistakable odor of smut or which after the removal of dockage 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, is classified as smutty wheat.

The standards provide two optional methods for grading Smutty Wheat.

1. Smut dockage: (This method is used in the far Western States.) If the wheat is smutty, a 500-gram portion of the dockage-free wheat is placed in a laboratory wheat scourer where the smut is removed. The loss in weight of the wheat (not the weight of the smut removed) that is caused by this removal of the smut is computed in terms of percentage based on the total weight of the grain when free from dockage. The percentage of smut dockage thus computed is stated in terms of half percent, whole percent, or whole-and-a-half percent, as the case may be. The percentage of smut dockage so calculated and stated is added to the grade designation preceding the statement of dockage, if any. Any fraction of a percent less than ½ percent is disregarded.

2. Light Smutty and Smutty: (This method is in general use east of the Rocky Mountains.) In the case of wheat, which before the removal of dockage has an unmistakable odor of smut, or which after the removal of dockage 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, the term "Light Smutty" is added to, and made a part of, the grade designation.

In case smut balls are present in excess of a quantity equal to 30 balls of average size in 250 grams of wheat, the designation "Smutty" is added to, and made a part of, the grade designation.

Smut in wheat and rye is objectionable because the smutty odor may pass into the flour and the black smut spores may discolor it.

SMUTTY RYE, BARLEY, OATS, GRAIN SORGHUMS, AND MIXED GRAIN

Special grades of smutty rye, smutty barley, smutty oats, smutty grain sorghums, and smutty Mixed Grain apply when the smut present exceeds the limitations specified in the definitions for smutty in these grains.

SPECIAL RED OATS

The increased production of Columbia Red oats, which have been found equal in processing value to White oats, led to the adoption of the special grade Special Red oats applicable to Columbia Red oats and to other red oats having similar characteristics.

Columbia Red oats range in color from an almost white through light tan, grayish brown, and brown to reddish cast, having conspicuous light colored veins running lengthwise of the kernels.

Oats of the special grade Special Red oats may not contain more than 10 percent of other cultivated oats. An example of the special grade is No. 2 Special Red oats.

STAINED WESTERN BARLEY

Any Western Barley (excepting Bleached Barley) that is badly stained or weathered is graded as Stained, and when such barley is so graded the word "Stained" is added to, and made a part of, the grade designation, as, for example, No. 2 Western Barley, Stained.

TEST WEIGHT OF WESTERN BARLEY

Test weight per bushel is not a grading factor for determining the numerical grade of Western Barley. (See Handbook of Official Grain Standards (*12*).) Instead, the test weight per bushel is added to, and made a part of, the grade designation, following the name of the class. The test weight is expressed in terms of whole pounds, and a fraction of a pound is disregarded. An example of this special grade designation is No. 3 Western Barley, 45 pounds.

THIN OATS

Thin oats are 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 perforated with slots 0.064 inch wide by ⅜ inch long (small chess sieve) (fig. 7, *C*).

The test for "thin" oats is made by hand-sieving a representative portion of the original sample. Approximately 1⅛ quarts of oats should be used but not more than one-third of this portion should be on the sieve at any one time. The sieve is held level and shaken in a steady manner 20 times (left to right and return) in such a way that the oats move lengthwise of the slots. The material that passes through the sieve in this operation is resieved over the small buckwheat hand sieve (fig. 7, *B*) to remove the "fine seeds." The small undersized oats that passed through the small chess sieve and from which the fine seeds have been removed are then weighed and the percentage of thin oats is computed on the basis of the weight of the portion that was tested. An example for the use of this special grade designation is No. 2 White Oats, Thin.

TOUGH GRAIN

The special grade designation "Tough" applies to the standards for wheat, barley, oats, Feed oats, Mixed Feed oats, rye, and Mixed Grain. The minimum and maximum moisture limits for tough grade of the various grains are shown in table 4. When the moisture content exceeds the maximum percentage allowed in the special grade "Tough," the grain is then graded "Sample grade."

An example of the use of the special grade designation "Tough" is as follows: No. 2 White Oats, Tough. The designation "Tough" does not apply in the case of corn, grain sorghums, flaxseed, or soybeans.

TABLE 4.—*Minimum and maximum moisture limits for tough grain*

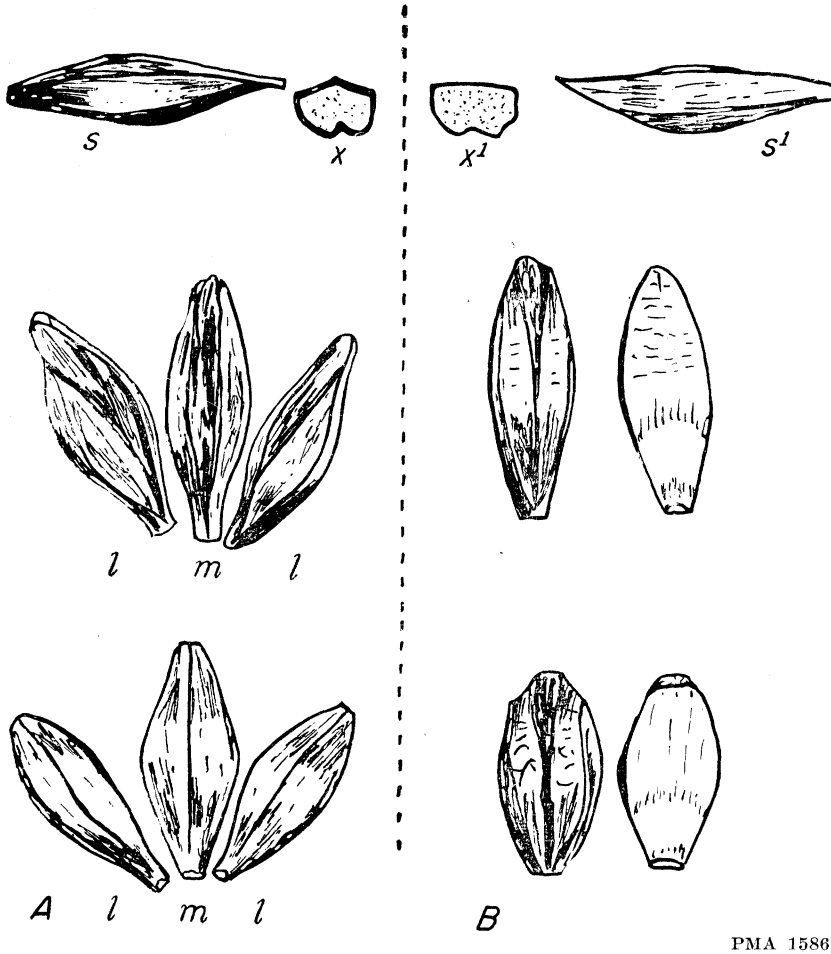
Grain	Moisture content of tough grain	
	In excess of—	Not to exceed—
Wheat:	*Percent*	*Percent*
Hard Red Winter, Soft Red Winter, and White	14	15.5
Hard Red Spring, Durum, and Red Durum	14.5	16
Barley:		
Barley (class I) and Black Barley	14.5	16
Western Barley	13.5	15
Oats, Feed oats, and Mixed Feed oats	14.5	16
Rye	14	16
Mixed Grain	14.5	16

TWO-ROWED BARLEY

Two-rowed barley consists of Two-rowed barley of the subclass Barley, of the class Barley, or of the class Western Barley that does not meet the requirements for the special grades Choice Malting Two-rowed Barley and Malting Two-rowed Barley (p. 62), and may not contain more than 10 percent of Six-rowed barley. To determine the percentage of Two-rowed barley in any sample, approximately 30 grams of the dockage-free barley are analyzed and if the barley does not contain more than 10 percent of Six-rowed barley, the word "Two-rowed" is added to, and made a part of, the grade designation, preceding the name of the class or subclass, as the case may be. An example of this special grade designation is No. 1 Two-rowed Barley.

Identification of Two-rowed and Six-rowed Barley.—In the field two-rowed and six-rowed barleys are differentiated by the arrangement of the kernels in the spike or head. In two-rowed barley there are only two rows of kernels in each head, while a six-rowed barley spikelet group consists of three kernels and thus six rows appear in each head. The two outside kernels in a spikelet group in six-rowed barley are called lateral kernels, and are usually thinner than the center kernel. The lateral kernels have a twisted appearance which is one of the principal identification marks of all six-rowed barleys in the threshed grain. Six-rowed kernels are illustrated in figure 13*A* and two-rowed kernels in figure 13*B*.

A knowledge of varietal characteristics is required in order to make a satisfactory analysis for two-rowed and six-rowed barley. The diagrams in figure 13 illustrate some of the characteristics that are used in identifying two- and six-rowed barleys.



PMA 15861

FIGURE 13.—*A*, Six-rowed barley; *s*, side view; *x*, cross section; *l*, lateral kernels; *m*, middle kernels. *B*, two-rowed barley; x^1, cross section; s^1, side view; no lateral kernels.

SIX-ROWED (Figure 13*A*)	TWO-ROWED (Figure 13*B*)
A prominent ridge on the top or germ side curving downward at both ends of the kernel (*s* and *x*).	Center ridge not prominent. Top of kernel flat. Edges prominent and tip opposite germ up-curving (s^1 and x^1).
Drawn out in bottle-neck shape at germ end with in-curving sides (m).	Wedge-shaped at germ end with sides of kernel straight.
Kernels may or may not be twisted (l and m).	Kernels never twisted.

Two-rowed kernels generally have a thinner skin than six-rowed barleys and the skin is often transversely wrinkled. Typical two-rowed kernels are plump and rounded on the crease side and when poured onto a table or flat surface will often be observed with the rounded side up and resting firmly on the flat dorsal side of the kernel. The prominent dorsal ridge in six-rowed barleys generally prevents this position on a flat surface.

Those interested in a further study of barley varieties are referred to Technical Bulletin No. 907, entitled Classification of Barley Varieties Grown in the United States and Canada in 1945 (*1*).

For discussion of the special malting grades for Hannchen and Hanna barleys, see Appendix I, p. 62.

WEEVILY GRAIN

The official standards provide that grain, except flaxseed, shall be graded "Weevily" if infested with live weevils or other insects injurious to stored grain (fig. 14). Some insects eat the grain, while others bore into it and lay eggs in the kernels. These eggs hatch into larvae that feed upon the interior of the kernels. Weevil-infested grain generally is useless for seed and its value is low for processing, because the kernels may be so gnawed and bored by the growing larvae or mature weevils that little or no substance is left. Besides consuming the grain the weevils leave much offensive offal mixed with the grain. When weevily grain is officially graded, the word "Weevily" is added to the grade designation.

"Live weevils" include rice weevils, granary weevils, and lesser grain borers. "Other insects injurious to stored grain" include the live beetles, moths, mealworms and other insects injurious to stored grain described in Farmers' Bulletin No. 1260 (*2*). The presence of any live weevil or other insect injurious to stored grain indicates the probability of infestation and warns the inspector that the grain must be carefully examined to determine whether it is infested.[6] The presence of a single live weevil should not be considered as conclusive evidence that grain is infested since the single live weevil found may be incidental. In such cases, the balance of the representative sample should be examined or one or more extra cuts of a running stream should be taken and examined immediately before reaching a conclusion as to whether or not the grain is infested.

APPARATUS FOR GRADING GRAIN

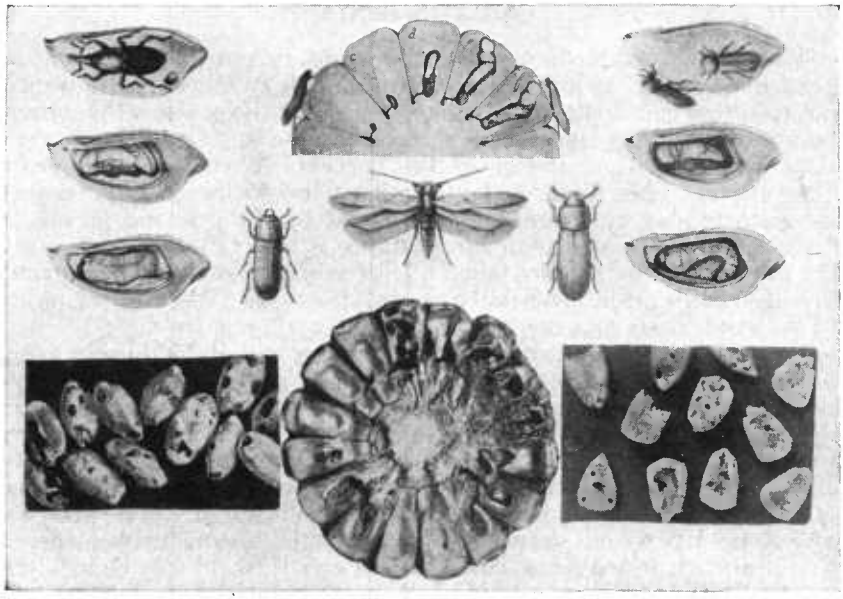
It is difficult to specify the grain-grading apparatus that anyone, other than a licensed grain inspector, should have available if he is to grade grain. In the Corn Belt a moisture tester is essential when the new corn crop is placed on the market, but it is not nearly so important in many of the wheat-producing areas, except during a wet harvest. In the spring wheat area of the central Northwest, equipment for removing dockage is necessary, whereas in parts of the winter wheat areas there is little dockage and a full set of this equipment is not greatly needed. In other parts of the hard winter wheat region dockage is of importance. Flaxseed and grain sorghum sieves are needed

[6] When a considerable number of live Angoumois moths are noted on top of the grain in a railroad car or other container, their presence, for the purposes of determining the special grades for Weevily grain, is evidence of infestation.

only in rather restricted areas. The electrically operated dockage testers are good labor savers for busy country elevator operators.

However, unless wild oats, cultivated oats, or barley become mixed with wheat, a dockage tester of one of the types elsewhere described is not absolutely essential, because most of the coarse material can be removed by a hand scalper sieve ($^{12}/_{64}$-inch round-hole perforations), and the fine material consisting mostly of small weed seeds can be removed from the grain with the small buckwheat or the fine-seed ($^{1}/_{12}$-inch round-hole perforations) sieve. (See p. 22 for method of operation.)

The test weight per bushel of any grain is an important indication of its market value, for this test is a measure of the plumpness of the



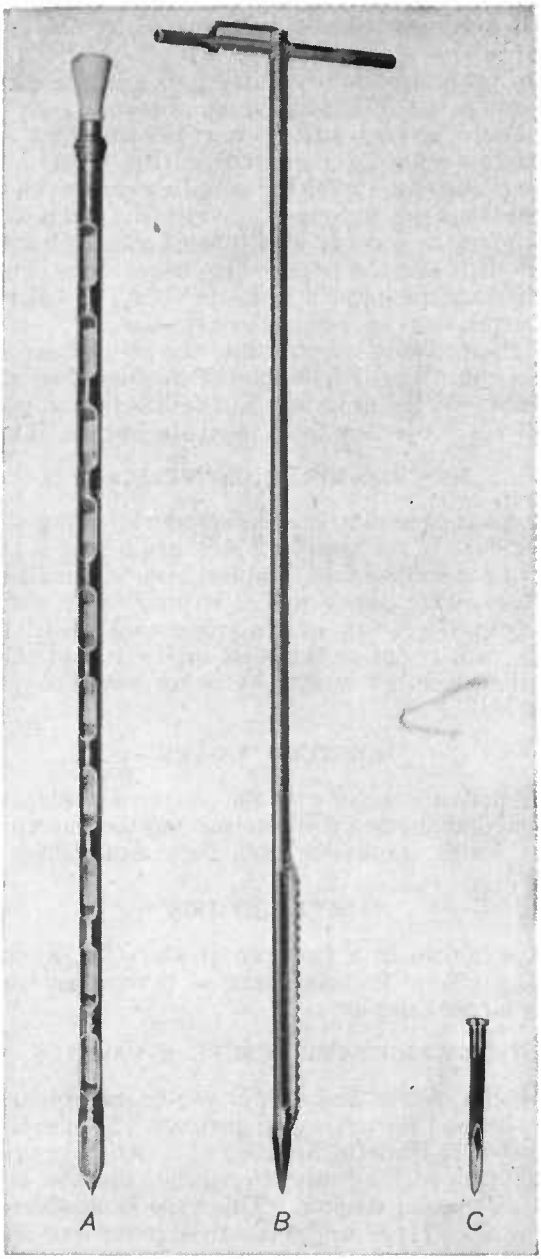
PMA 10652

FIGURE 14.—Grain kernels damaged by weevils and other insects injurious to stored grain. (Left) The granary weevil, which is chestnut brown or black in color and $^{3}/_{16}$ inch or less in length. (Right) The lesser grain borer (Australian weevil), which is dark brown or black in color, cylindrical in form and small ($^{1}/_{8}$ inch long by $^{1}/_{32}$ inch wide). (Center) The Angoumois moth, which is a small buff or yellowish brown moth, with a wing expanse of $^{1}/_{2}$ inch. Two so-called bran bugs or flour beetles are shown right and left of center. These small reddish beetles are about $^{1}/_{8}$ to $^{1}/_{6}$ inch long.

grain. It is imperative that the test-weight-per-bushel equipment be available.

As such separations as mixtures of other grains, other classes, damaged grain, weed seeds, and other foreign matter must be weighed in the process of testing, a dependable scale or balance must be on hand.

The pieces of apparatus that are used by grain inspectors are described in the following pages.



PMA 1232

FIGURE 15.—*A*, Double-shelled compartment grain probe used for sampling bulk grain; *B*, a probe used for sampling ear corn in cribs; *C*, a small probe used for sampling sacked grain.

PROBES

Representative samples should be obtained by the use of a grain probe.

The standard probe used for sampling bulk grain in cars is a double-shell slotted brass probe 62⅞ inches long. Between each slot the inner shell (tube) should be separated by partitions so that each slot will be the entrance to a separate compartment (fig. 15, *A*).

The ear corn probe (fig. 15, *B*) for sampling corn on the ear has been developed in recent years in connection with the commodity loan program. This apparatus consists of a tube of cold-rolled steel, sharply pointed and slotted near the point. One edge of the slot bears a row of teeth for shelling the kernels from the cobs. It has an inner tube which can be turned so as to open or close the slot.

To operate, the probe is inserted into the crib of ear corn between the slats of the crib. The inner tube is then turned so as to open the slot and by means of the cross bar in the handle the whole probe is rotated so that the projecting teeth shell the kernels into the slot.

SPOUT SAMPLER OR "PELICAN"

For obtaining a representative sample from a falling stream of bulk grain, and particularly for sampling bulk grain that is being spouted into the holds of a vessel, a spout sampler, generally called a "pelican," is used (fig. 16). This device makes it possible to obtain complete cross sections from the stream of grain being sampled. In operation, the stream of grain is cut at frequent intervals and the samples so obtained are then reduced in size by being put through a Boerner divider (fig. 2).

MOISTURE TESTER

The electric moisture meter and the Brown-Duvel moisture tester are the practical devices used for determining the moisture content of any grain for which standards have been established (figs. 9, 10, and 11).

SAMPLE DIVIDER

An apparatus known as a Boerner divider (fig. 2) is used in all grain inspection offices for obtaining a thoroughly representative portion from a larger sample.

TEST-WEIGHT-PER-BUSHEL APPARATUS

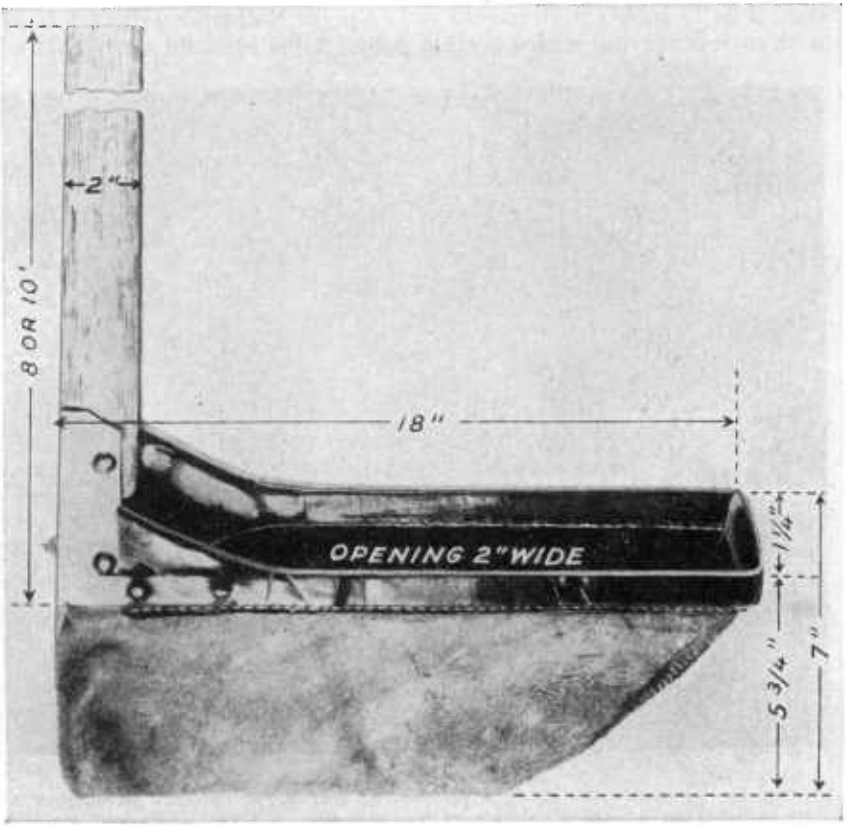
Several reliable types of test-weight-per-bushel apparatus now on the market can be used for testing all grains. The official type (fig. 8) is the one described in Bulletin No. 1065 (*4*). Another type is a standard bucket and beam with a funnel to regulate the flow and fall of the grain and with a special stroker. This type is considerably less expensive than the official type, and if the directions for its use are strictly followed, it will give results comparable with those obtained by the official tester.

BALANCES

Large size.—For weighing all portions of grain in excess of 50 grams, a balance should be available that has a graduated beam sensi-

tive to one-tenth of a gram and with a set of weights from 1 gram to 1,000 grams. It is used for weighing all large-sized portions of the original samples that are to be tested for dockage, moisture content, cracked corn and foreign material, and for any other determination that involves a weight of more than 50 grams (fig. 17).

Small size.—For weighing all small portions of a sample, there should be available a balance with a capacity of 50 grams with a gradu-



PMA 9931

FIGURE 16.—Spout sampler (pelican) used for sampling bulk grain delivered from a spout.

ated beam to read 1 gram and fractions of a gram and sensitive to one-hundredth of a gram. A set of weights from 1 gram to 50 grams should be provided for this balance (fig. 17).

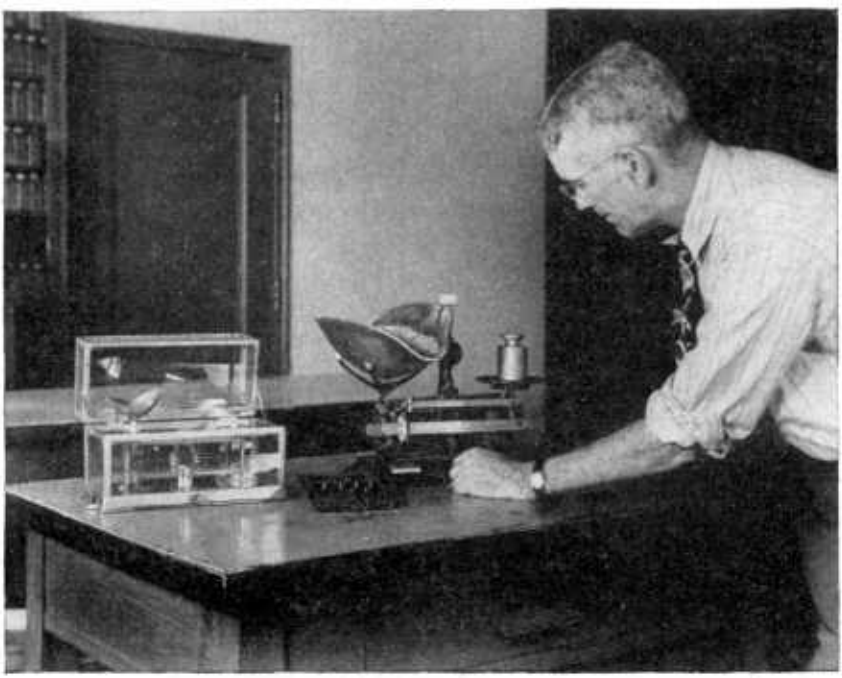
DOCKAGE TESTER

Two types of devices are in common use for removing dockage material from wheat, rye, barley, grain sorghums, and flaxseed and for the removal of cracked kernels and foreign material from corn and grain sorghums. One is the Carter dockage tester (fig. 18) used by

all grain inspection supervisors and by many licensed inspectors; another is the Emerson dockage tester (fig. 19). Each is equipped with specially constructed sieves or riddles.

SIEVES

A set of standard hand sieves (fig. 7) made from metal 0.032 inch thick is needed to supplement the machine sieves and riddles of the Carter dockage tester and the Emerson dockage tester. These sieves should be 13 inches in diameter and so made that they will nest freely with each other and with a bottom pan. A list of hand sieves that are



PMA 15611

FIGURE 17.—Operator weighing a portion of wheat for dockage determination by using a large torsion balance with a capacity of 1,200 grams and sensitive to 1/10 gram. At the left is a small torsion balance with a capacity of 50 grams and sensitive to 1/100 gram. This balance is used for weighing analytical separations, such as for damaged and heat-damaged grain.

sometimes used is given in the following paragraphs. The operator need procure only those sieves that he considers necessary for the kinds of grain that he intends to grade. All sieves should be tested occasionally with standard gages for accuracy. This is especially true if a sieve is used frequently and is thus subject to wear.

Accuracy of perforations.—The diameter of round-hole perforations and of the inscribed circle of triangular perforations, and the width of slotted perforations should meet the tolerance of plus or minus 0.0005 inch. The accuracy of perforations of sieves used by Federal grain supervisors is checked by means of "go" and "no go" cylindrical plugs.

Corn sieve.—The corn sieve (fig. 7, *A*) is perforated with round holes 12/64 inch in diameter. It is used for removing cracked corn and foreign material from corn when the grader does not have either of the dockage testers heretofore mentioned. It is used also as a scalper

FIGURE 18.—Carter dockage tester, electrically operated. (See figure 20 for details of operation.)

sieve to remove coarse foreign matter from wheat and rye in the dockage determination of these grains when either of the dockage testers is not in use.

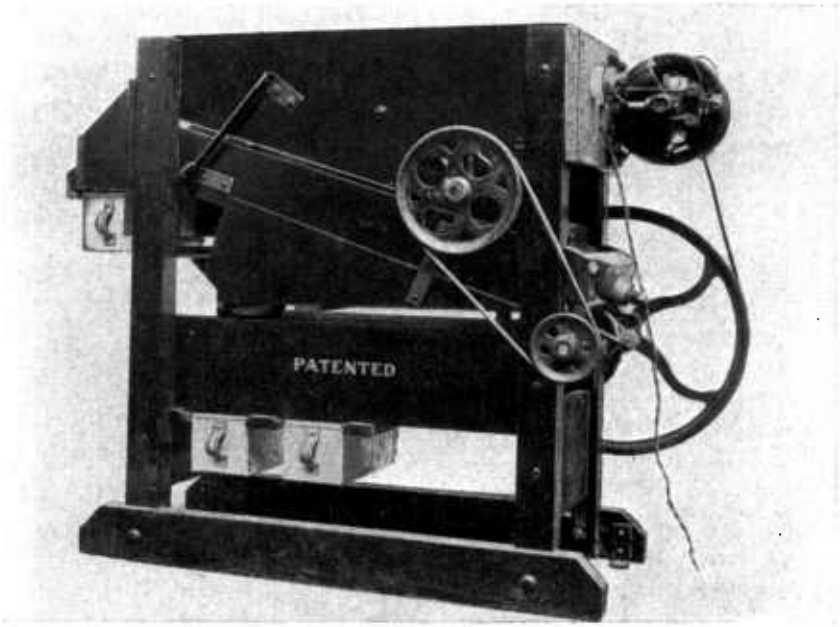
Soybean foreign material sieve.—The sieve used in the foreign material determination in soybeans is perforated with round holes 8/64 inch in diameter.

Sieves to facilitate determination of splits in soybeans.—Although the determination of splits in soybeans is not based on a sieving test, nevertheless hand sieves with slotted perforations $^{8}/_{64}$ or $^{9}/_{64}$ or $^{10}/_{64}$ by $^{3}/_{4}$ inch are useful in facilitating the determination.

Fine seed sieve.—The fine-seed sieve (fig. 7, *E*) has round-hole perforations $^{1}/_{12}$ inch in diameter. It is used for removing fine seeds, such as mustard, in dockage determinations in wheat and rye.

Grain sorghums dockage sieve.—The dockage sieve for grain sorghums, with round-hole perforations $2^{1}/_{2}/64$ inch in diameter, is used in making dockage determinations of grain sorghums.

Small buckwheat sieve.—The small buckwheat sieve (fig. 7, *B*) has equilateral triangular perforations, the inscribed circles of which are



PMA 9496

FIGURE 19.—Emerson dockage tester, electrically operated.

$^{5}/_{64}$ inch in diameter. It is used for removing such seeds as wild buckwheat, pigeongrass, and seed of similar size in dockage determinations in wheat and rye, as a part of the equipment for determining dockage in barley, and for removing "fine seeds" in connection with the sizing test for Thin oats.

Small chess sieve.—The small chess sieve (fig. 7, *C*) has slotted perforations 0.064 inch wide by $^{3}/_{8}$ inch long. It is used for removing large-seeded flaxseed from wheat, for determining the factor "thin oats" in the grading of oats, for determining "shrunken and/or broken kernels" in wheat, and "thin or undersized kernels" in rye.

Large chess sieve.—The large chess sieve (fig. 7, *D*) has slotted perforations 0.070 inch wide by $^{1}/_{2}$ inch long. It is used for removing chess seeds, quackgrass, and similarly shaped seeds from wheat.

Barley-sizing sieves.—A sieve with slotted perforations 47/8/64 inch wide by 3/4 inch long is used for removing thin barley in grading "eastern" six-rowed malting barley. A sieve with slotted perforations 51/2/64 inch wide by 3/4 inch long is used for removing thin barley in the grading of "western" two-rowed malting barley.

Barley scalper sieve.—The barley scalper sieve with slotted perforations 9/64 inch wide by 3/4 inch long is used in the determination of dockage in barley for removing coarse foreign material, such as corn, soybeans, sticks, and straw.

Flaxseed sieves.—One of the flaxseed sieves is perforated with round holes 41/2/64 of an inch in diameter. This sieve is used to facilitate the removal of small seeds from flaxseed in the determination of dockage in flaxseed.

Another kind of flaxseed sieve which has slotted perforations 3/64 inch wide by 3/8 inch long, is sometimes used. It is especially useful for separating cereal grains and other coarse material from flaxseed, and may be used for removing flaxseed from wheat when determining dockage in wheat.

For a complete list of flaxseed dockage sieves, see "Flaxseed Dockage Determination," page 23.

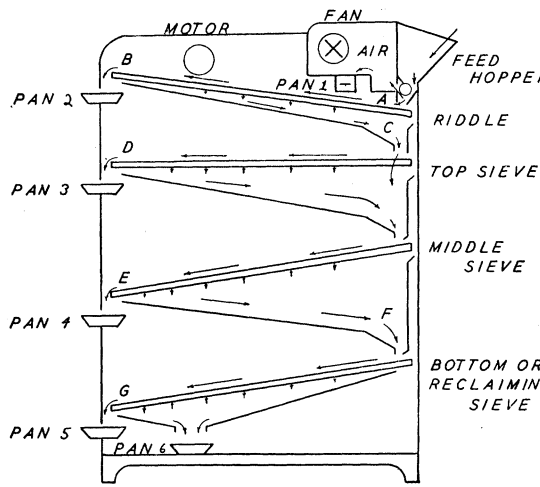


FIGURE 20.—Operations performed by Carter dockage tester on samples of wheat: *A*, Sample being discharged from feed hopper passes through air stream onto riddle and the material removed by air drops into pan 1; *B*, tailings (coarse dockage) discharged over riddle drops into pan 2; *C*, grain that passed through riddle drops into riddle hopper which directs wheat to top sieve, or to middle sieve when no sieve is used in top position; *D*, clean grain passes over top sieve into pan 3 when top sieve is employed; *E*, in cases where no top sieve is used, clean grain passes over middle sieve into pan 4, but when the middle sieve is used as a reclaiming sieve, the reclaimed material passes over the sieve into pan 4; *F*, the material passing through the middle sieve is directed to the bottom sieve for reclaiming or further separation; *G*, reclaimed material passing over the bottom sieve drops into pan 5; and fine dockage passes through sieve and drops into pan 6.

BARLEY PEARLER

The barley pearling machine assists inspectors to determine whether there is present a sufficient quantity of mellow (starchy) kernels in the grain to permit the barley to be graded as Malting Barley. Furthermore, the pearler is almost indispensable for detecting heat damage in barley (fig. 6).

INCREASING THE VALUE OF GRAIN

The grading factors discussed in this publication measure class, quality, and condition and are the basis on which inspectors assign grades to grain. Many of the conditions that are measured by these grade-determining factors are under the control of the farmer or grain handler. Examples of the conditions that are under the control of the farmer or grain handler follow.

Wheat may be assigned a lower grade because it is composed of a mixture of different classes, or because it contains an excess quantity of rye, weed seeds, or smut. Grain is sometimes assigned a low grade because it has a musty odor or because it contains an excess quantity of damaged kernels as a result of the grain having been put into storage while it was still too damp. Barley that has been threshed too closely may not qualify for the highest classification or the highest grade.

The selection of suitable varieties, the recommended cultural methods, proper seed treatment, harvesting when the grain is mature, careful threshing and subsequent handling, all have an important influence on the elimination of factors which lower the grade and value of the grain crops.

The improved quality of market receipts of grain in recent years is noticeable. Some areas have eliminated rye mixtures in wheat. Chess and cockle have been cleaned out in others. The top grades of malting barley are now produced where "feed" barley formerly was grown.

The educational work conducted by State extension services and crop-improvement organizations has accomplished much in increasing the quality of the grain produced. Hundreds of grain-grading schools for farmers and grain dealers have been held, where samples of grain were examined and the quality problems of the community were discussed (fig. 21). Pure-seed campaigns and rod-row variety demonstrations have been used to good purposes. All of these efforts have encouraged farm practices valuable to both the producer and the buyer. Grain of higher grade has been grown and marketed and the entire industry has benefited.

FURTHER INFORMATION

The information contained in this publication pertains to the most important grading problems that are encountered in grain inspections. Local and seasonal conditions may require some other special grading procedure than is here described, but it is believed that the abbreviated instructions and definitions in this publication should prove useful to those grain producers and handlers who are not familiar with the full technical routine employed by official grain inspectors.

Grain inspection supervisors are located at most of the large grain markets. Upon request they will give advice and further information regarding grain-grading problems.

In addition to the Official Handbook of Grain Standards (*12*) circulars covering the grading of certain grains have been prepared and are available to those who are interested (*10*), (*11*), (*13*), (*14*), (*15*), (*16*), (*17*), (*18*). Miscellaneous Publication No. 328 of the United States Department of Agriculture, "The Service of Federal Grain Standards," describes the commercial inspection system and points out some of the benefits of the United States Grain Standards Act to grain growers (*9*).

A free copy of any of the publications just referred to and of this grain grading Primer may be obtained from any of the offices listed on pp. 60 and 61 of this publication.

PMA 15616

FIGURE 21.—A grain-grading school for county extension agents, conducted in cooperation with the South Dakota Extension Service.

The Production and Marketing Administration maintains a cooperative project with the Extension Service at the Post Office Building, Chicago, Ill. This project deals with educational work on the marketing of grain at country points. Also, licensed grain inspectors are located in nearly every terminal grain market, so that approximately 200 grain-inspection offices and laboratories are distributed throughout the country. It is suggested that anyone who is interested in this subject visit one or more of these grain-inspection offices and observe the way in which grain is sampled, inspected, and graded, under commercial conditions.

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OFFICES OF THE PRODUCTION AND MARKETING ADMINISTRATION AT WHICH GRAIN INSPECTION SUPERVISORS ARE LOCATED

(May 1953)

Albany 1, N. Y.—307 New Post Office Building.
Baltimore 2, Md.—801 U. S. Appraisers Stores.
Boston 9, Mass.—701-A U. S. Custom House.
Buffalo 3, N. Y.—340 Post Office Building.
Cedar Rapids, Iowa—200 Post Office Building.
Chicago 7, Ill.—1204 Post Office Building.
Cincinnati 2, Ohio.—509 Post Office Building.
Decatur, Ill.—324 Standard Office Building.
Denver 2, Colo.—573 U. S. Custom House.
Duluth 2, Minn.—338 Post Office Building.
Enid, Okla.—319 Post Office Building.
Fort Worth 2, Tex.—404 U. S. Court House.
Galveston, Tex.—216 Post Office Building.
Grand Forks, N. Dak.—2003 Skidmore Avenue.
Great Falls, Mont.—251 Post Office Building.
Hoboken, N. J.—225 Post Office Building.
Hutchinson, Kans.—200-A Post Office Building.
Indianapolis 4, Ind.—215 East New York Street, Room 303.
Kansas City 6, Mo.—325 U. S. Court House.
Los Angeles 12, Calif.—1534 Post Office Building.

Louisville 2, Ky.—301 Post Office Building.
Memphis 3, Tenn.—404 Hickman Building.
Milwaukee 2, Wis.—642 Post Office Building.
Minneapolis 1, Minn.—116 Federal Office Building.
Nashville 3, Tenn.—500 U. S. Court House.
New Orleans 12, La.—333 St. Charles Street, Room 1401.
New York 7, N. Y.—139 Centre Street, Room 805.
Ogden, Utah—379 Post Office Building.
Omaha 2, Nebr.—506 Omaha Grain Exchange Building.
Peoria 2, Ill.—355 Post Office Building.
Philadelphia 6, Pa.—1002 U. S. Custom House.
Portland 9, Oreg.—525 Post Office Building. (P. O. Box 3781.)
St. Joseph 54, Mo.—331 Post Office Building.
St. Louis 1, Mo.—1001 U. S. Court House and Custom House.
San Francisco 11, Calif.—749 New Appraisers Building, 630 Sansome Street.
Seattle 4, Wash.—622 Federal Office Building.
Sioux City 16, Iowa—208 Post Office Building.
Spokane 8, Wash.—415 Post Office Building.
Toledo 4, Ohio—337–347 Summit-Cherry Building.
Wichita 2, Kans.—204 Palace Theater Building.
General Field Headquarters, Chicago 7, Ill.—1108 Post Office Building.
Pacific Coast Field Headquarters, Portland 5, Oreg.—345 U. S. Court House.

Appendix I

SPECIAL MALTING GRADES FOR HANNCHEN AND HANNA BARLEY

Malting grades of Hannchen and Hanna barley become effective July 1, 1950.

Two new special grades are added to the official standards—Choice Malting Two-rowed Western Barley and Malting Two-rowed Western Barley. The Choice Malting special grade is limited to barley of the Hannchen or Hanna varietal types which contains not more than 3 percent of other varietal types and which also meets the requirements for grade No. 1 Western Barley. Also such barley must have a test weight of at least 52 pounds and contain not more than 5 percent thin barley and not more than 5 percent of skinned and broken kernels. The Malting special grade applies to grades 1, 2, and 3 Western Barley of the Hannchen or Hanna varietal types which contain not more than 5 percent of other varietal types, which have a test weight of at least 50 pounds, and which contain not more than 10 percent of thin barley and not more than 10 percent of skinned and broken kernels. Frosted, steely, smutty, garlicky, ergoty, bleached, or stained barleys are excluded from these special grades.

The sieve used for determining "thin" or "undersized" barley in the above special grades for Hannchen and Hanna barley has slotted perforations 5½/64 by ¾ inch wide, while a smaller perforation (4⅞/64 by ¾ inch) is used in the seive for making this determination in the "eastern" Malting barley subclass.

The new malting grades for two-rowed barley apply only to Hannchen or Hanna varietal types grown west of the Great Plains area. The malting subclass for six-rowed barley applies to qualified six-rowed barley grown east of the Rocky Mountains. Table 5 shows the specifications for "eastern" six-rowed malting and "western" two-rowed Malting barleys.

TABLE 5.—*Specifications for eastern 6-rowed and western 2-rowed malting barleys, by subclass or special grade*

Subclass and special grade	Type	Limit of unsuitable types—as 2-rowed, trebi, or black	Grade requirements	Mellow requirements	Limit thin barley (percentage through 4⅞ sieve)	Limit skinned and broken	Limit damaged	Test weight per bushel
		Percent		*Percent*	*Percent*	*Percent*	*Percent*	*Pounds*
Subclass: (A) Malting Barley [1]	Eastern 6-rowed.	5	1–3	75	15	5	4	43
Special grades:		Limit of other varietal types			(Percentage through 5½ sieve)			
Choice Malting 2-rowed Western Barley.[2]	Hannchen or Hanna.	3	1	80	5	5	2	52
Malting 2-rowed Western Barley.[2]	do	5	1–3	60	10	10	7	50

[1] Excludes bleached and semisteely barley.
[2] Excludes bleached, semisteely, frosted, smutty, garlicky, ergoty, and stained barley.

For complete grade specifications, see Handbook of Official Grain Standards (*12*). Except for the larger perforations in the sizing sieve, the laboratory procedure for determining the malting factors of thin barley, mellow kernels, skinned and broken, and damaged barley are the same as described for "eastern" 6-rowed Malting on pp. 18–20.

Appendix II

QUICK REFERENCE CHART FOR GRADING PROCEDURES

Steps to be followed in grading the usual run of grain at the country elevator.

ALL GRAINS

(1) Smell all samples and examine for presence of insects, heating, stones, and cinders, and other obvious conditions that may affect the quality of the grain.

(2) Cut the sample to 1⅛ to 1¼ quarts through the Boerner sampler, filling an airtight container for moisture testing with some of the left-over portion. When using electric tester, insert a thermometer in a rubber cork and use as a cover for the airtight container. (Fig. 9, p. 28.)

References: Grading procedure in general (pp. 7–8). Sample grade and distinctly low quality grain (pp. 37–39). Special grades such as Blighted, Ergoty, Garlicky, Smutty, Tough, and Weevily (pp. 39–49). After the preliminary examination the necessary determinations are made. Ordinarily, only the limiting factor needs to be determined. (For further study, page references are given under individual grain headings.)

CORN

(1) See item (1), above.

(2) Make test weight (p. 25), using the 1⅛ to 1¼ quarts as specified in step (2) above.

(3) Determine moisture (pp. 27, 28).

(4) Remove cracked corn and foreign material (p. 35) using test weight portion (1⅛ to 1¼ quarts). Look for insects in the screenings.

(5) Cut cleaned sample to approximately 250 grams and pick for damage (p. 32). Pieces of cracked corn too large to pass through the 12/64 sieve function as sound unless otherwise damaged.

(6) If it is necessary to make color determinations, use the 250-gram portion (step 5). (See corn classes, p. 17.)

(For further study, see references (*12*) and (*14*) listed on p. 60.)

SOYBEANS

(1) See item (1) under all grains, page 64.

(2) Make test weight (p. 25), using 1⅛ to 1¼ quarts (step 2, p. 64).

(3) Determine moisture (pp. 27–28).

(4) Cut sample to approximately 125 grams through a divider and determine foreign material, using the 8/64 round-hole sieve (p. 36). Pick off large foreign material remaining on top of the sieve and add to the foreign material that went through the sieve.

(5) Sieve a cut-down portion over the 8/64 round-hole sieve. Without removing any coarse foreign material, weigh the sieved portion and determine splits (p. 36).

(6) Use the sieved portion (step 5) to determine other colors and damaged kernels if necessary (pp. 33–34).

(For further study, see references (*12*) and (*13*) listed on page 60.)

WHEAT

(1) See item (1) under all grains (p. 64). Note Garlicky grade (pp. 43–44).

(2) Run dockage test (pp. 20–22). Look for insects in the screenings.

(3) Make test weight on dockage-free sample (p. 25).

(4) Determine moisture (pp. 27–28). (See p. 47 for Tough grade.)

(5) Analyze a 50-gram portion of dockage-free sample for foreign material and damaged grains (pp. 31–32, 37).

(6) Make smut ball determination on 250 grams of dockage-free sample (p. 45).

(7) Analyze 25 grams of dockage-free sample for wheats of other classes.

(8) Make subclass analysis (dark, hard, and vitreous kernels, etc.) on this 25-gram portion (pp. 16–17).

(For further study, see references (*11*), (*12*), and (*18*), p. 60.)

OATS

(1) See item (1) under all grains (p. 64).

(2) Determine test weight (pp. 25–26).

(3) Determine moisture (pp. 27–28). (Tough oats, p. 47.)

(4) Oats are divided into four groups on their general appearance, as follows:

(*a*) Bright, a special grade designation (p. 42).

(*b*) Unqualified or "straight" grade, may grade No. 1 or No. 2.

(*c*) Slightly weathered may grade no higher than No. 3.

(*d*) Badly stained or materially weathered, may grade no higher than No. 4.

(5) Cut sample to about 30 grams. Analyze for sound cultivated oats. Sound cultivated oats includes kernels, pieces of kernels, of cultivated oats, green immature kernels, oat groats, and hulled oats not otherwise damaged. (Oat clippings and detached oat hulls are considered as foreign material.) Analyses for foreign material, wild oats, and heat damaged kernels, if important, can be made on this 30-gram portion (pp. 35, 36).

(6) Make thin oats test on 1⅛ quarts of grain (p. 46).

(For further study, see reference (*12*), p. 60.)

GRAIN SORGHUMS

(1) See item (1) under all grains (p. 64).

(2) Make test weight (pp. 25–26).

(3) Determine moisture (pp. 27–28).

(4) Grain sorghums are divided into four groups on their general appearance, as follows:

(*a*) Bright, a special grade designation (p. 42).

(*b*) Unqualified or straight grade, may grade No. 1 to No. 4.

(*c*) Discolored, a special grade designation (p. 42).

(*d*) Badly weathered, grades Sample grade.

(5) Using 1⅛ to 1¼ quarts of the original sample, determine dockage with 2½/64 round-hole sieve. Look for insects in the screenings.

(6) Using the dockage-free sample, determine cracked kernels, foreign material, and other grains (a grade factor) (p. 35).

(7) Using 50 grams of the sieved cleaned grain, make further analysis for nongrain sorghums, damaged kernels, and class (p. 35).

Nongrain sorghums include broomcorn, Sudan grass, Johnson grass, and cane seed; damaged kernels include weevil-bored, sprouted, moldy, and heat-damaged grain sorghums, nongrain sorghums, and other grains.

(For further study, see references (*12*) and (*16*), p. 60.)

RYE

(1) See item (1) under all grains (p. 64).

(2) Determine dockage (pp. 22–23). Look for insects in the screenings.

(3) Run moisture test (pp. 27–28). Tough rye, p. 47.

(4) Make test weight (p. 25).

(5) Determine "thin rye" (pp. 44–45). "Thin rye" is restricted to 5 percent in the special grade "Plump" to 20 percent in grades No. 1 and No. 2, and to 30 percent in grade No. 3.

(6) Determine foreign material (pp. 36–37).

(7) Determine damaged and heat-damaged kernels.

(For further study, see reference (*12*), p. 60.)

FLAXSEED

(1) See items (1) under all grains (p. 64).

(2) Determine dockage (pp. 23–24).

(3) Run moisture test (pp. 27, 28) on sieve-cleaned flaxseed.

(4) Make test weight (p. 25), using 1⅛ to 1¼ quarts of the sieve cleaned flaxseed.

(5) Determine damaged kernels (p. 33).

(For further study, see references (*12*) and (*15*), p. 60.)

MIXED GRAIN

The standards provide a limit to "other grains" allowed, as follows:

In wheat, corn, rye, grain sorghums, and soybeans, 10 percent.

In flaxseed, 20 percent, and in barley and oats 25 percent.

When these limits are exceeded the sample is classed as mixed grain.

All determinations in mixed grain are on the basis of the original sample.

(1) See item (1) under all grains (p. 64).

(2) Determine the percentage of each kind of grain, and the percentage of foreign material. Wild oats are classed as a grain. Foreign material includes all matter other than grains for which standards have been established under the United States Grain Standards Act, except wild oats.

(3) Determine test weight.

(4) Determine moisture.

(5) Determine damaged and heat-damaged kernels on 30-gram portion.

(6) Mixed grain has two grades: Mixed Grain and Sample Grade Mixed Grain. The percentage and name of each kind of grain constituting over 10 percent of the mixture, as well as the term "foreign material" and the percentage thereof, are all shown as part of the grade designation. There are seven special grades, namely, Tough, Smutty, Ergoty, Garlicky, Weevily, Blighted, and Treated.

(For further study, see reference (*12*), p. 60.)

BARLEY

(1) See item (1) under all grains (p. 64).

(2) Run dockage test (p. 23).

(3) Make test weight on dockage-free sample (p. 25).

(4) Determine moisture (pp. 27–28).

(5) Determine class: Barley, class I, comprises white barley grown east of the Rocky Mountains. Western Barley, class III, comprises white barley grown west of the Great Plains area. Use the grade chart that applies. (See Handbook of Official Grain Standards (*12*).)

(6) Cut out a 30-gram portion from the dockage-free sample, and make determinations (steps 7–11) as follows:

(7) Sound barley includes skinned and broken kernels and green immature kernels (p. 34).

(8) Broken kernels (a separate grade factor).

(9) Foreign material (does not include other grains, wild oats, or smut masses).

(10) Blighted barley (p. 42).

(11) Wild Oats in Western Barley.

(12) Determine heat-damaged kernels. (Pearl a 50-gram portion.)

(13) Determine general appearance: Bright Western Barley and Stained Western Barley are special grades. Barley in class I and class II that is badly stained or materially weathered shall not be graded higher than No. 4.

For Malting Barley Subclass (pp. 18–20) determine:

(14) Sizing (p. 18).

(15) Mellowness (p. 18).

(16) Skinned and broken (p. 19).

(17) Damaged kernels (p. 20).

(18) Unsuitable malting types (p. 20).

For special grades for two-rowed Western Malting Barley, see Appendix I (pp. 62–63).

(For further study, see references (*10*) and (*12*), p. 60).

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