



Agricultural Marketing Service  
U.S. DEPARTMENT OF AGRICULTURE



# Federal Grain Inspection Service Corn Inspection

**The mission of the Federal Grain Inspection Service is to facilitate the marketing of U.S. grain and related agricultural products by establishing standards for quality assessments, regulating handling practices, and managing a network of federal, state, and private laboratories that provide impartial, user fee funded official inspection and weighing services.**





- **USDA inspection – Hallmarks**
  - 3<sup>rd</sup> party
  - Domestic inspection is voluntary
  - Export inspection is mandatory
    - Aflatoxin required
  - Inspection process and procedures
    - Multiple levels of review inspections
    - Sampling and processing through a structured process
    - Inspection results are admissible as prima facie evidence

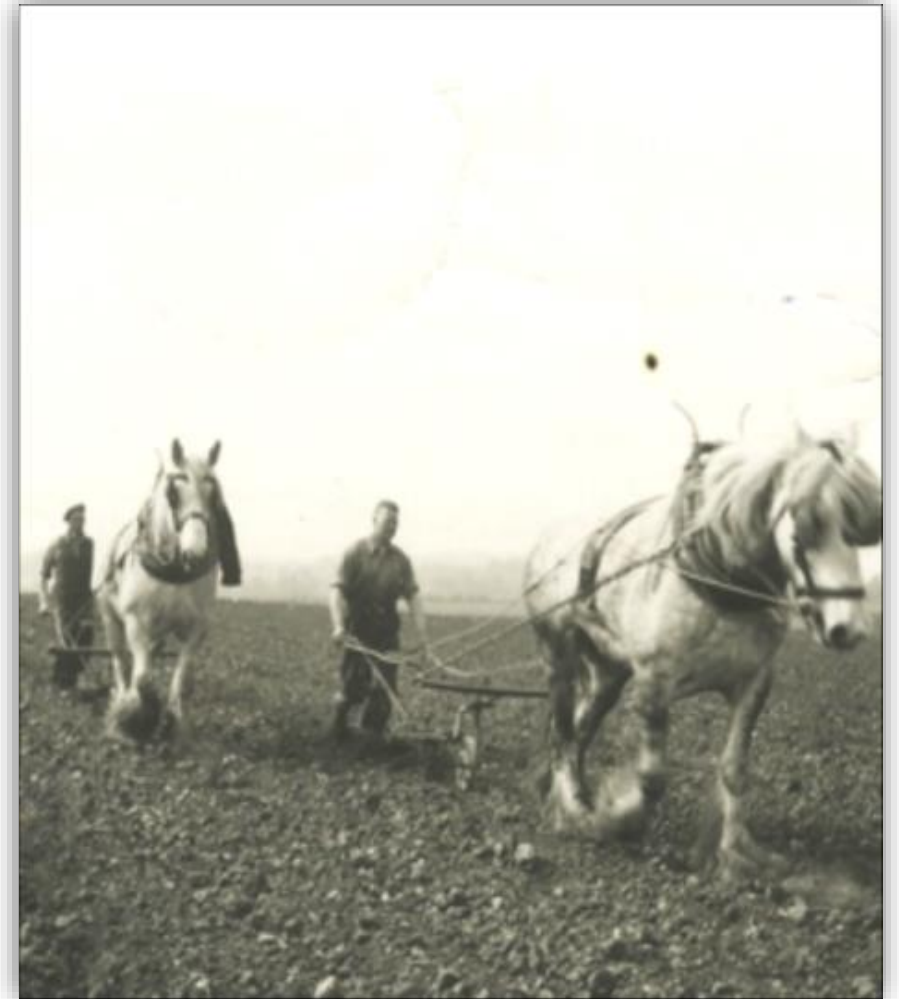
**The search for buyer-seller equity in establishing grain quality and quantity has generated conflict throughout the history of grain trading. As early as 750 B.C. there are biblical accounts condemning grain merchants for unfair practices, noting measures being small through the use of deceitful scales and low quality wheat selling with husks.**



**When the first settlers began growing grain, there were few problems of grain standardization, futures trading, or export markets.**

**In the late 1700's and early 1800's, farming was 90 percent of the workforce. It took approximately 250-300 labor hours to produce 100 bushels or 5 acres of wheat using a walking plow, brush harrow, hand broadcast of seed, sickle, and flail.**

**Grain was bartered for articles needed, was loaded on boats, and sent down the rivers to the coast towns where it was sold for local use. Generally, there was enough trust between parties that a simple handshake could "seal the deal".**



## 1800's Grain Farming

**With American agriculture moving forward, the tools and machinery used in farming were also advancing. In 1834, Cyrus McCormick patented the Reaper which allowed farmers to harvest grain much more efficiently than before. Over time the prairies produced a surplus of grain to sell in foreign markets.**

**As settlement expanded westward through the Ohio Valley and over the plains beyond the Mississippi, there emerged a vast harvest of grain a long distance from the centers of consumption. This led to quality discrepancies due in part to the way the business of buying and selling grain was being conducted in different parts of the country. So this lack of uniformity and confusion in the grain market led grain merchandisers to establish their own standards and procedures on a market-by-market basis.**

**1847  
McCormick  
Reaper**



**The practice of individual dealers issuing their own written statements of grain quality did not prove very satisfactory, and was eventually taken over by chambers of commerce and boards of trade. These organizations developed systems for grading and employed inspectors to grade the grain.**

**Grain was first graded in the United States in 1857 by inspectors employed by the Chicago Board of Trade. In 1858, the Detroit Board of Trade established grain inspection and appointed a chief inspector. Detroit was followed by the Milwaukee Chamber of Commerce in 1859, the Toledo Board of Trade in 1860, the Cleveland Board of Trade in 1864, and the St. Louis Merchants Exchange in 1865. Other cities followed, establishing their own grades and appointing inspectors.**

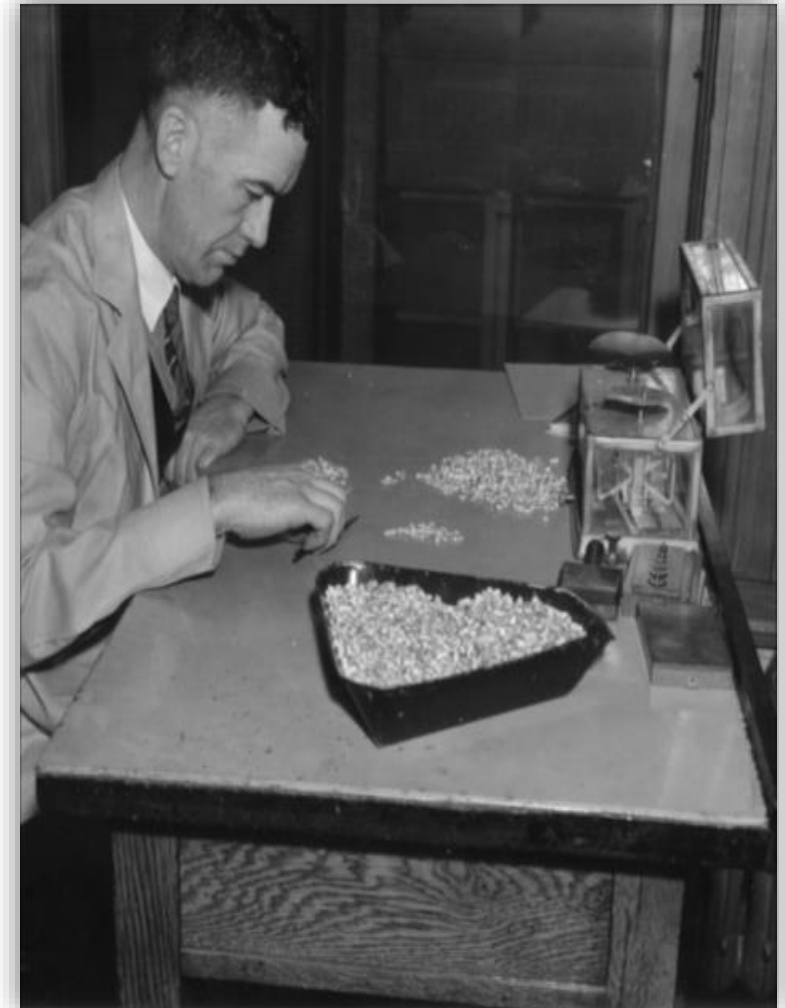


**The specifications of the various grades differed between the states and markets and often were indefinite.**

**For example, some standards required that:**

- **No. 2 corn be dry, others reasonably dry; one would require not more than 16% moisture, another not more than 15.5%.**
- **No. 3 oats alone was described or designated under 30 different specifications, and the test weight requirements for this grade varied from 22 to 29 pounds per bushel.**

**These market-by-market grades and grading procedures caused confusion in the grain market. Each market had its own grades or methods for interpreting grades and sometimes the certificate of grade issued in one market was not recognized in another.**

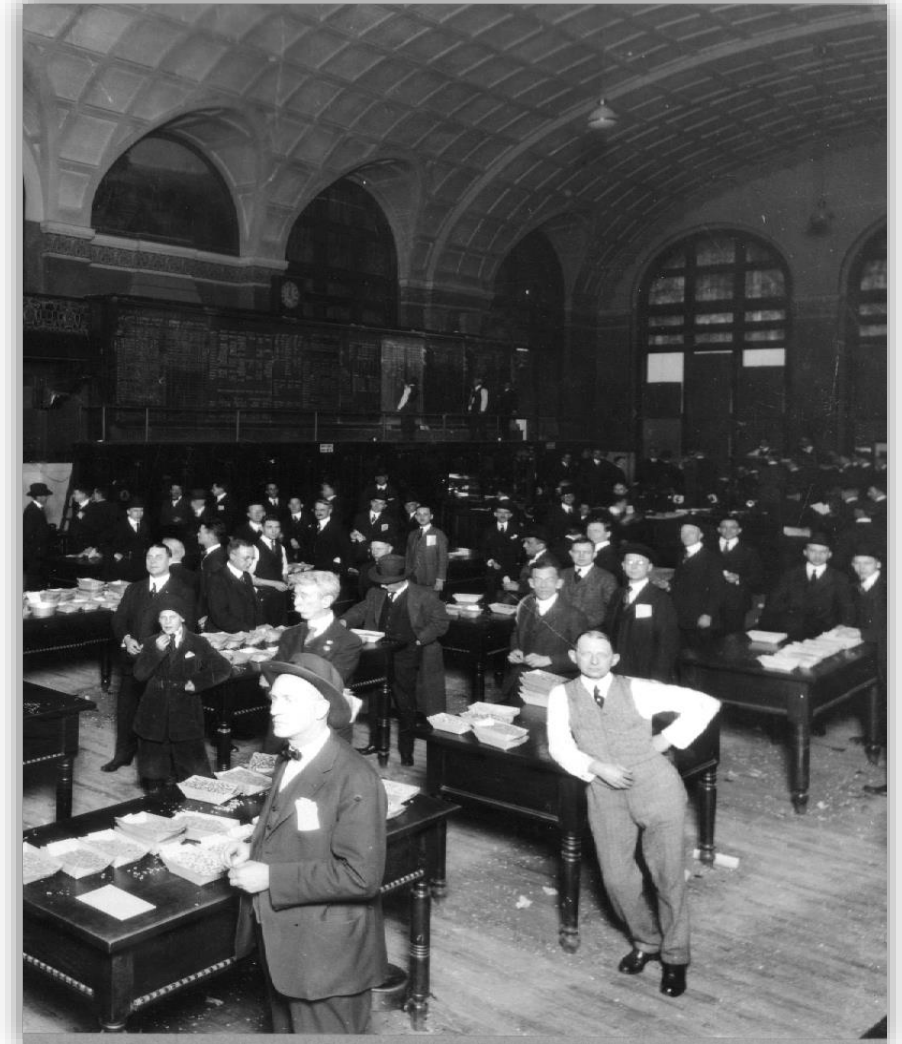




**In June 1906, at its annual convention the Grain Dealers National Association (GDNA) formed the Uniform Grades Congress. The UGC was comprised of delegates from all markets having public inspection and was charged with devising uniform standards for grain grading and uniform terminology to describe the standards.**

**The UGC found that the grades for grain used in the principal markets were so diverse as to be almost meaningless. They found that the description of grades for grain with the same name varied greatly among the markets.**

**“A study of the phraseology of the grain trade in 1906 disclosed 338 names or grade titles: 133 for wheat, 63 for corn, 77 for oats, 53 for barley, 10 for rye, and 1 each for “no grade” and “no established grade.”**



**Although the GDNA did not accomplish its original goal of voluntary standards, its search for uniformity and objectivity provided the basis for legislation that might not have passed the Congress otherwise. On August 11, 1916, after years of hearings and deliberations, the 64th Congress of the United States approved and the President signed into law the U.S. Grain Standards Act of 1916. The rapid implementation of the grades promulgated by the USDA, and the efficiency they brought to the chaotic grading of the previous fifty years, are a credit to the educational programs of the GDNA.**



**President Woodrow Wilson**

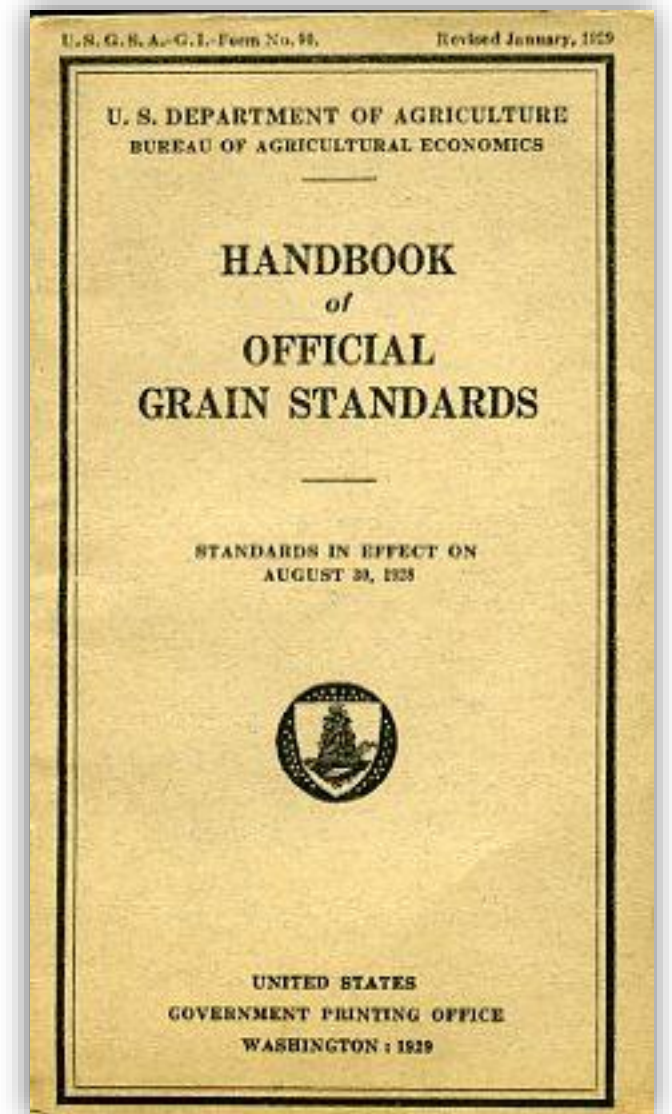
**The U.S. Grain Standards Act (USGSA) of 1916 gave the federal government authority to establish uniform standards which applied to all grain sold or shipped by grade in interstate and foreign commerce from or to an inspection point and to establish a supervisory organization to oversee the application of the standards.**

## **USGSA Commodities Regulated**

**Soon after the act was passed Federal standards for corn, wheat, and oats were established.**

**Later standards for rye, sorghum, barley, flaxseed, mixed grain and soybeans were added.**

**In more recent times, standards for triticale, sunflower seed, and canola were added.**



Grade	Minimum test weight per bushel (Percent)	Maximum Limits of-----		
		Damaged Kernels		Broken Corn and Foreign Material (Percent)
		Heat Damaged Kernels (Percent)	Total (Percent)	
U.S. No. 1	56.0	0.1	3.0	2.0
U.S. No. 2	54.0	0.2	5.0	3.0
U.S. No. 3	52.0	0.5	7.0	4.0
U.S. No. 4	49.0	1.0	10.0	5.0
U.S. No. 5	46.0	3.0	15.0	7.0

U.S. Sample grade is corn that:

- (a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4, or 5; or
- (b) Contains stones which have an aggregate weight in excess of 0.1 percent of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria* spp.), 2 or more castor beans (*Ricinus communis* L.), 4 or more particles of an unknown foreign substance (s) or a commonly recognized harmful or toxic substance(s), 8 or more cockleburs (*Xanthium* spp.) or similar seeds singly or in combination, or animal filth in excess of 0.20 percent in 1,000 grams; or
- (c) Has a musty, sour, or commercially objectionable foreign odor; or
- (d) Is heating or otherwise of distinctly low quality.

**Sample or random variation, which is unavoidable, is largely responsible for the variation we see. Since it is not practical to examine the entire lot, we must estimate quality factors based on a much smaller sample.**

**For instance, a 2800 gram hopper car sample, which represents 3,000 bushels of corn, is drawn. But, because it is not practical to analyze this amount in the time afforded inspectors, the original sample is further reduced to a smaller 1000 gram work portion for dockage and test weight, but even this is reduced to more workable sub-portions for other factors.**



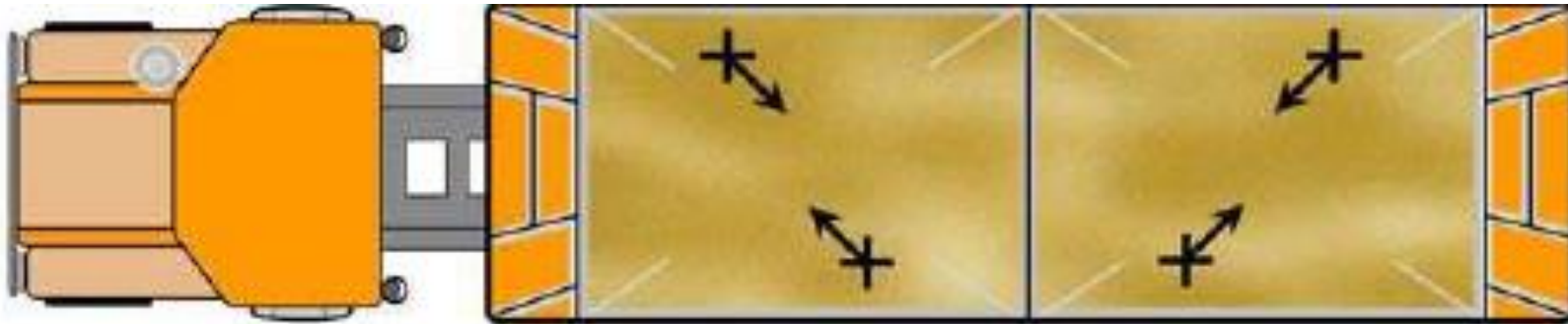
**How a sample is selected from a lot is of vital importance because the result of an inspection performed on the sample represents the entire lot.**

**Only randomly selected samples allow you to employ laws of probability and draw conclusions about the entire lot. A randomly selected sample is where every kernel in the lot has an equal chance of being included in the sample.**



# Representative of the lot

**For instance, a sample taken from a truck is said to be "representative" of the truck. Using a single probe may not give every kernel in the lot an equal chance of being selected, but by taking multiple probes throughout the truck, the sampling method has been shown to be a reasonable approximation to random sampling. The official sampling procedures include probing patterns for various carrier types.**



**The sampling method on a submitted sample is usually unknown so the inspection results for that sample only represent that sample, not the lot it was taken from.**

## Kernel Size and Portion Sizes

**The larger the kernel size the larger the sample required to reduce variability. For Example, damage is determined on a 15 gram portion in wheat a 125 gram portion in soybeans and a 250 gram portion in corn.**

**Non uniform distribution of the constituent to be measured also will require a larger sample.**





**Determine the class of corn by the color characteristics of the kernels.**

**Classes:**

- **Yellow Corn**
- **White Corn**
- **Mixed**

**When an analysis for class is necessary, use a 250-gram portion of BCFM-free corn.**



- **Special grades are provided to emphasize special qualities or conditions affecting the value and are added to and made a part of the grade designation.**
- **They do not affect the numerical or sample grade designation.**
- **The corn standards include four special grades:**
  - Flint
  - Flint and Dent
  - Infested
  - Waxy



**Infested Corn.** Corn that is infested with live weevils or other live insects injurious to stored grain.



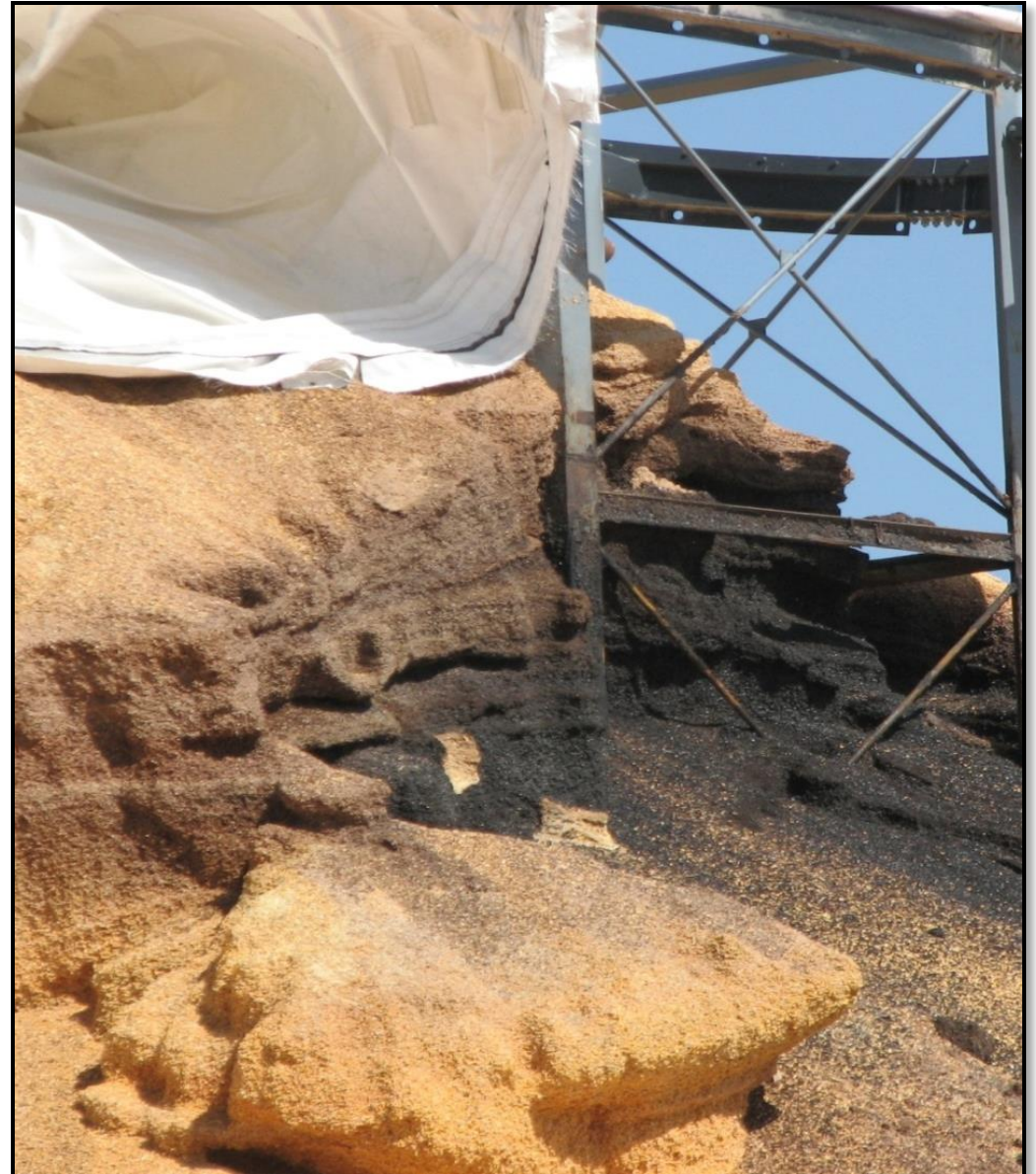
**Waxy Corn.** Corn that consists of 95 percent or more waxy corn.

**Corn developing a high temperature due to microbial activity is considered heating.**

**Heating corn, in its final stages, will usually have a sour or musty odor.**

**Determine heating on evidence obtained at the time of sampling or on the basis of the sample as a whole.**

**Grade heating corn as U.S. Sample Grade and record the word "Heating" in the "results" section of the certificate.**



**Consider corn distinctly low quality when it is obviously of inferior quality and the existing grade factors or guidelines do not accurately reflect the inferior condition. Use all available information to determine whether the corn is of distinctly low quality. This includes a general examination of the corn during sampling and an analysis of the obtained sample(s).**

**Corn containing two or more stones, pieces of glass, pieces of concrete, or other pieces of wreckage or debris which are visible to the sampler but are too large to enter the sampling device is considered distinctly low quality.**

**Corn that is obviously affected by other unusual conditions which adversely affect the quality of the corn and cannot be properly graded by use of the grading factors specified or defined in the standards is considered distinctly low quality.**

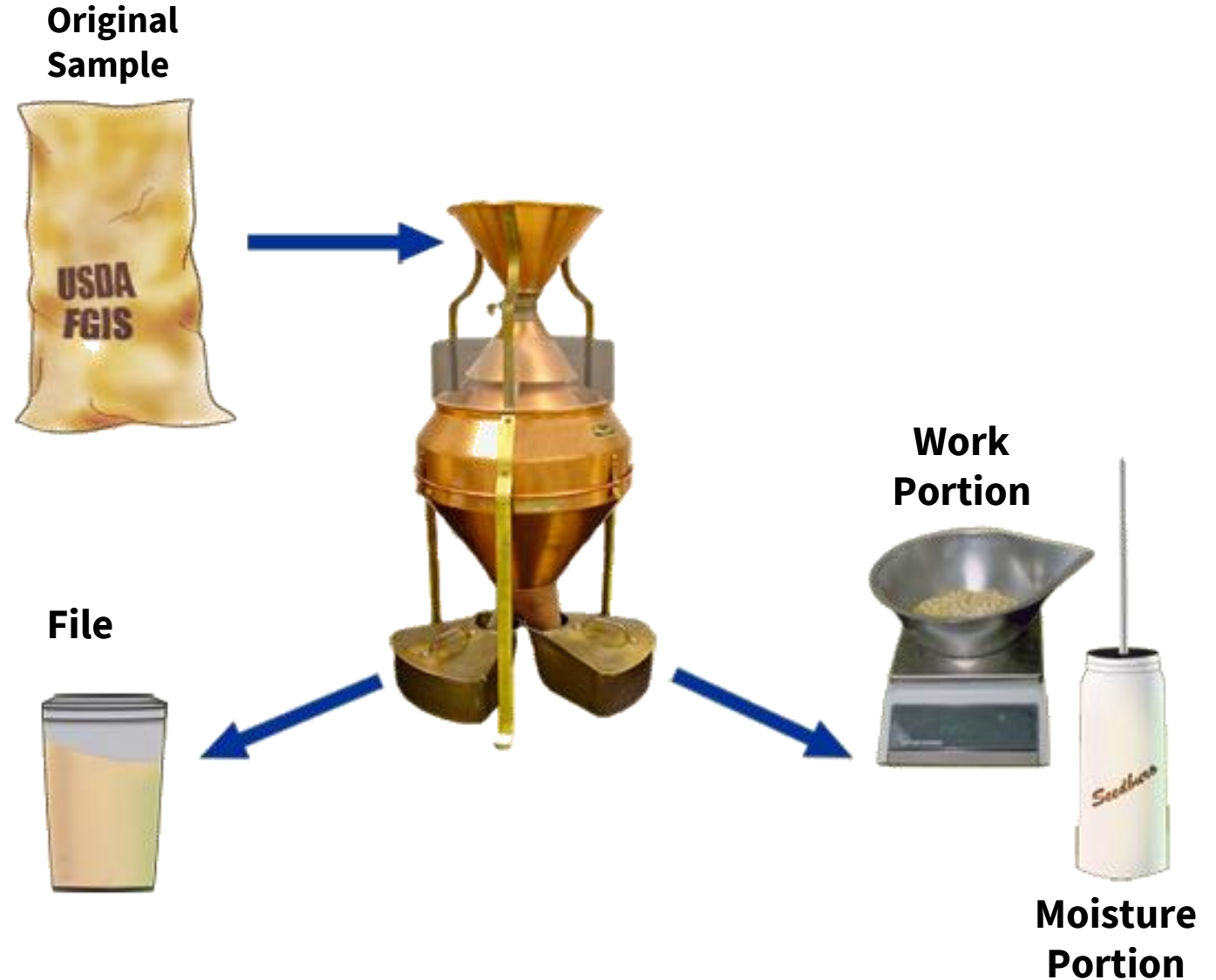
**Grade distinctly low quality corn as U.S. Sample Grade. Record the words "Distinctly Low Quality" and the reason(s) why in the "results" section of the certificate.**



# Processing the Original Sample

The first step in grading a corn sample is to use a Boerner divider to reduce the original sample into the following portions:

- A file sample of approximately 1400 grams.
- A Work portion of approximately 1000 grams.
- A moisture portion of approximately 400 grams.



Boerner divider reduces the size of a grain sample while maintaining the representativeness of the original sample.

Each pass of the sample through the divider splits the sample into two equal representative portions.



**A “file sample,” is a representative sample or representative portion of a sample that is retained for a specified period of time for reference or review purposes.**

**File samples should be of sufficient size to accommodate subsequent examinations or analysis.**

**The file sample shall be an unworked portion (if available) of the representative sample used for the inspection.**

**The worked portion may be retained as the final file only when insufficient sample is available for an unworked file sample.**





# Moisture Proof Containers

**Keep all samples in sealed moisture proof containers if they cannot be tested within approximately 15 minutes.**

**Do not use paper bags, fiber cartons, or similar containers that allow moisture losses.**

**Use metal cans, plastic containers, and plastic bags to preserve the sample integrity.**

**Do not file samples with paper identification inserted in the grain.**



**Test weight per bushel is the weight per Winchester bushel or 2,150.42 cubic inches.**

**The determination for test weight is made on the work portion before the removal of broken corn and foreign material on a portion of sufficient quantity to overflow the kettle.**



# Broken Corn and Foreign Material

**Broken Corn and Foreign Material** (BCFM) is all matter that passes readily through a 12/64 round-hole sieve and all matter other than corn that remains in the sieved sample after sieving according to procedures prescribed in FGIS instructions.

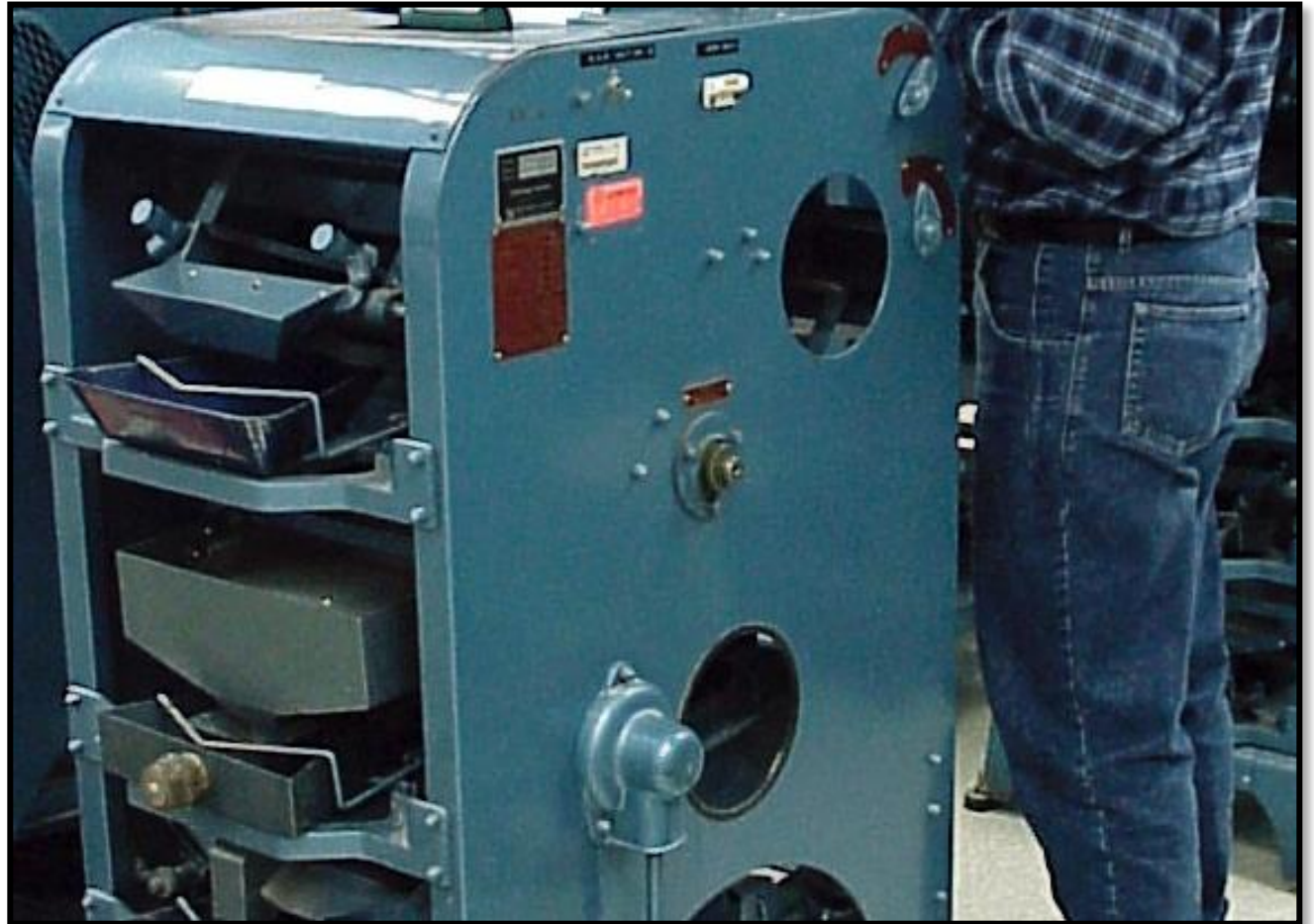
**Broken Corn**: All matter that passes through a 12/64 round-hole sieve and over a 6/64 round-hole sieve.

**Foreign Material**: All matter that passes through a 6/64 round-hole sieve and all matter other than corn that remains on top of the 12/64 round-hole sieve.



**The procedure is performed in two steps:**

**A mechanical separation of BCFM is made using a Carter Dockage Tester to remove the larger and finer particulate matter.**



**The procedure is performed in two steps:**

**A mechanical separation of BCFM is made using a Carter Dockage Tester to remove the larger and finer particulate matter.**

**The mechanically cleaned sample is then handpicked to remove any remaining similarly sized foreign material from the sample.**



**Check the material found in the BCFM sieve catch pans for:**

- live weevils and other live insects injurious to stored grain,
- stones,
- distinctly low quality, and
- other sample grade factors.

**Hand sieving the work portion *is not* recognized as an official method.**



**Remove all matter other than corn,  
including sweet corn, popcorn, and blue  
corn.**



**Combine the handpicked and the mechanically separated BCFM.**





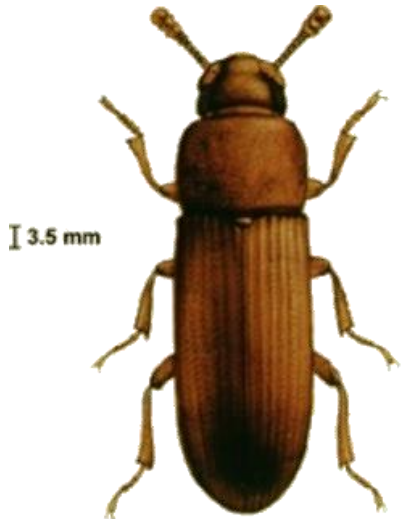
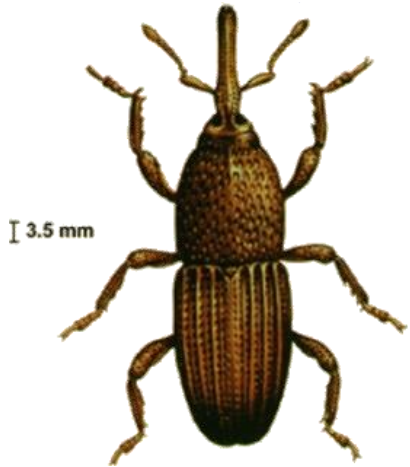
**Determine odor on evidence obtained at the time of sampling or on the sample either before or after the removal of BCFM.**

**Odors are classified as OK, Musty, Sour, or COFO (commercially objectionable foreign odors).**





# Check for Insects



<b>INSECT INFESTATION</b>
<i>Samples meeting or exceeding any one of these tolerances are infested:</i>
2 Live Weevils
1 live weevil plus 5 other live insects injurious to stored grain
10 other live insects injurious to stored grain
Live weevils include rice weevils, granary weevils, cowpea weevils, maize weevils, and lesser grain borers. Other live insects injurious to stored grain shall include grain beetles, grain moths, and larvae.

**Examine the sample for Sample Grade factors such as animal filth, glass, stones, toxic seeds, and unknown foreign substances.**

**Also check for special grade factors such as flint, flint and dent, waxy, and infested.**

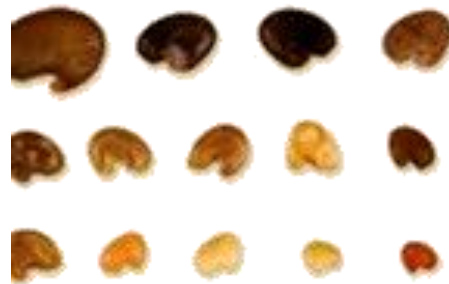


**Cocklebur**

**Stones**



**Filth**



**Crotalaria**



**Castor Bean**

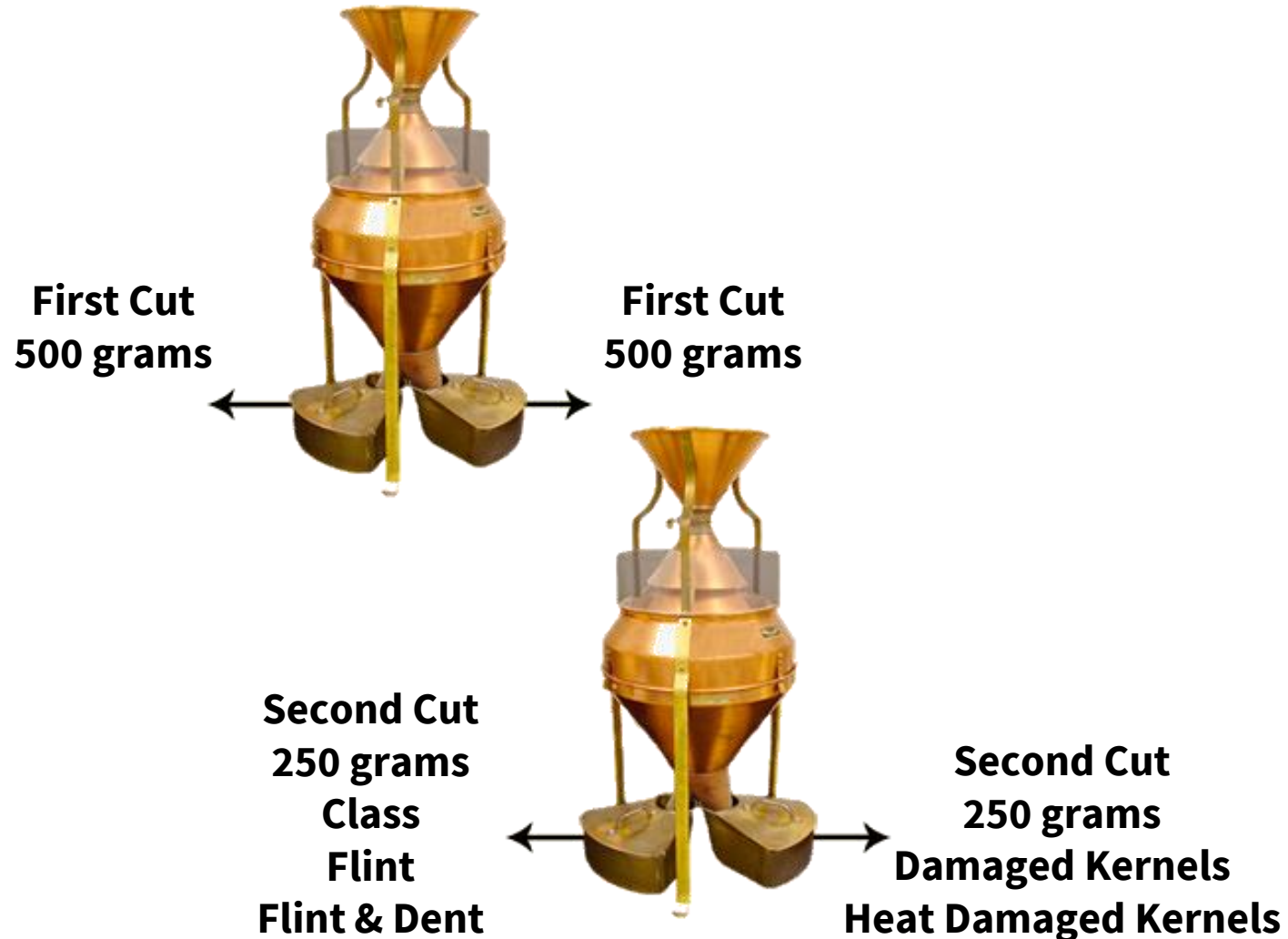
# Analytical Portion (250 grams)

**After determinations have been made for odor, test weight, moisture, BCFM, infestation, and sample grade factors, cut out a 250 gram portion for analyzing Damaged Kernels and Heat Damaged Kernels.**

**When an analysis for class, flint, or flint and dent is necessary, cut out an additional 250-gram portion.**

**If it is necessary to determine whether the special grade Waxy applies, use exactly 100 kernels cut out of a 35-gram portion of BCFM-free corn.**

**Work Sample (BCFM Free)**

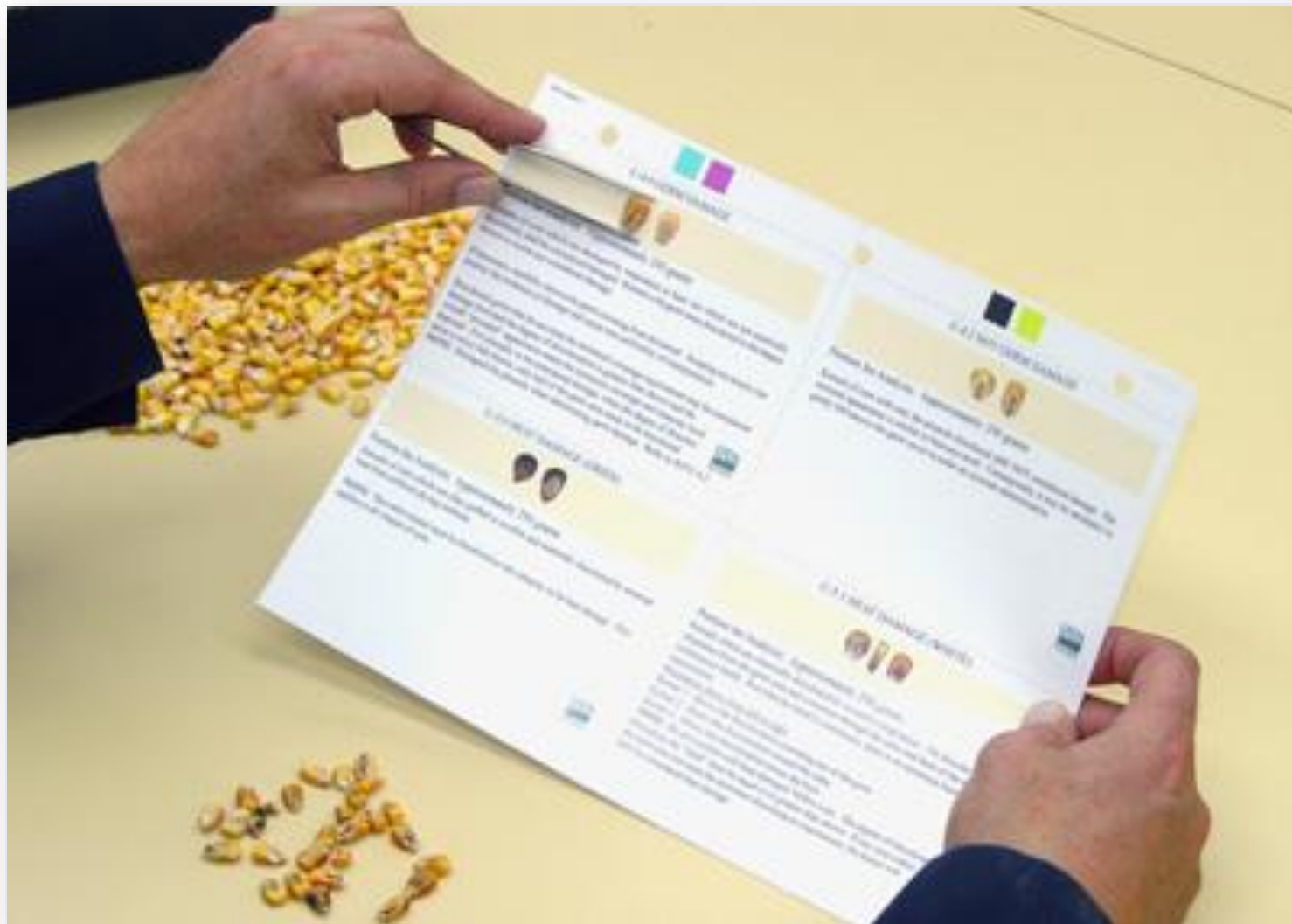


# Damaged Kernels Total

- **Damaged kernels are kernels and pieces of corn kernels that are badly ground-damaged, badly weather-damaged, diseased, frost-damaged, germ-damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged, or otherwise materially damaged.**
- **A kernel of corn is considered damaged for inspection and grading purposes when the damage is distinctly apparent and of such character as to be recognized as damaged for commercial purposes.**



- **Used to ensure that interpretations are uniformly and consistently applied throughout the national system.**
- **Provide a basis for communicating the minimum “line” for various types of damage and other visually determined criteria.**



**A germ infected with blue-eye mold, regardless of amount.**

**If the mold is distinct, it is not necessary to open or scrape the kernel.**

**Otherwise, lift the germ cover carefully to avoid destroying the evidence of mold.**



**Do not confuse purple plumule with blue-eye mold.**

**Purple plumule is not damage but is a genetic or varietal characteristic.**

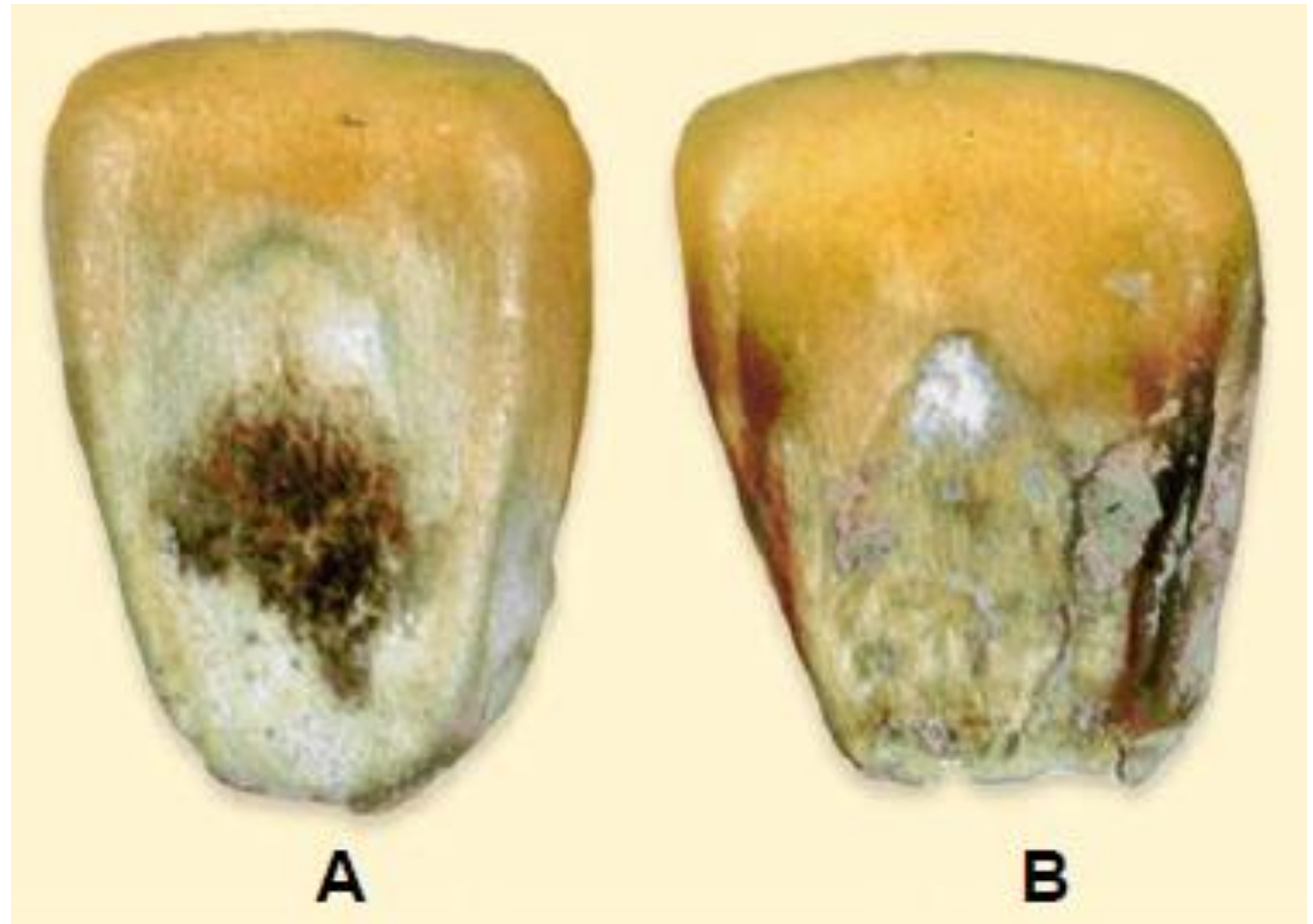




**Cob rot is caused by a fungus that attacks weakened plants.**

**It is detected by the presence of a distinct discoloration or rotting.**

**Opening the kernel is not required to detect cob rot but may be necessary to determine the extent of other types of damage.**



**Kernels and pieces of kernels which have a discolored, wrinkled, and blistered appearance; or which are puffed or swollen and slightly discolored and which often have damaged germs; or whose seed coats are peeling off or have already peeled off; or which have a fractured or checked appearance resulting from external heat caused by artificial drying methods.**



**Do not confuse drier damage with heat damage (drier).**

**Kernels and pieces of kernels damaged by microbial activity but not materially discolored.**

**In most cases, the germ covering will have to be removed, exposing the area around the plumule.**

**The discoloration must extend into the meat of the germ to be considered damaged.**



**Kernels of corn with only the plumule discolored are not considered damage.**



**Kernels and pieces of kernels which are puffed or swollen and materially discolored by external heat caused by artificial drying methods**



**Kernels and pieces of kernels which are materially discolored by microbial activity, with the dark discoloration extending out of the germ through the sides and into the back of the kernel.**



**Yellow Corn**

**Kernels and pieces of kernels with obvious insect-bored holes or which have tunneling, insect webbing, or insect refuse.**

**Do not consider kernels partially eaten but entirely free from refuse, webbing, insects, or other forms of damage as damaged.**

**Do not cut open the kernel when making this determination.**



**Kernels and pieces of kernels infected with mold on exposed endosperm.**

**When a kernel of corn has been broken exposing the starch, it becomes susceptible to mold. Check broken pieces carefully for mold.**

**Do not confuse kernels that have dirt on them with kernels containing mold. Mold is usually blue or green in color.**





**Whole or broken kernels which have dirt on the exposed part of the kernel are not damaged.**



**Kernels and pieces of kernels with mold in silk cuts.**

**Kernels with clean silk cuts and are otherwise sound are not considered as being damaged.**





**Sprouted kernels or those showing evidence of a sprout.**



# Surface Mold Damage (blight)

**Kernels and pieces of kernels which have mold caused by corn leaf blight on them which appears to be only on the surface but actually penetrates the seed coats.**

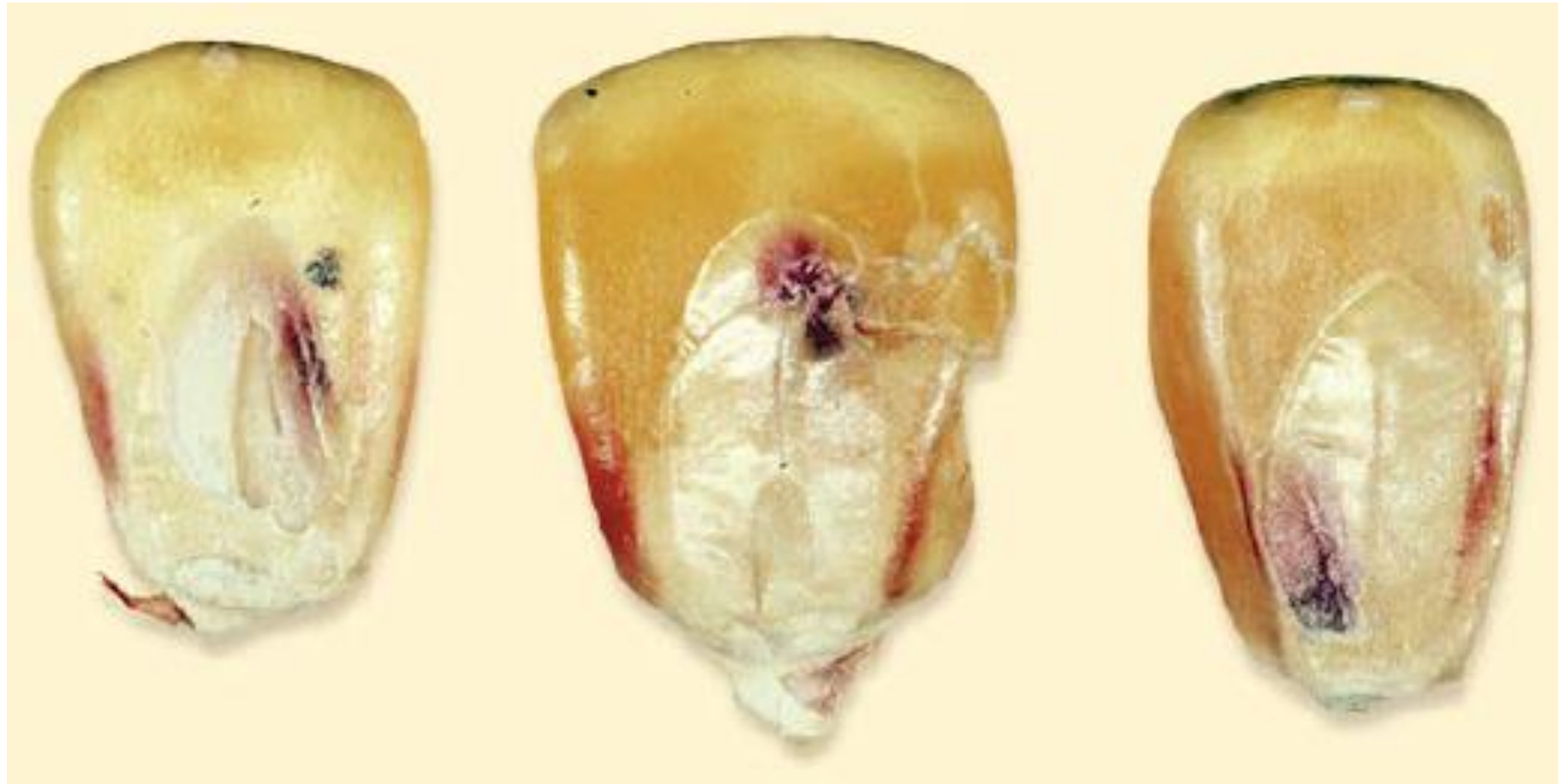


**Kernels and pieces of kernels which contain surface mold in any area or combination of areas equal to or greater than shown on the interpretive line slide.**



# Mold Damage (pink epicoccum)

**A germ affected with pink epicoccum mold, regardless of the size of the mold, is a damaged kernel.**



# Assign the Numerical Grade

- **Compare the result for each factor to the limits on the grade chart.**
- **The factor with the lowest grade designation determines the grade assigned to the sample.**

Grade	Minimum test weight per bushel (Percent)	Maximum Limits of-----		
		Damaged Kernels		Broken Corn and Foreign Material (Percent)
		Heat Damaged Kernels (Percent)	Total (Percent)	
U.S. No. 1	56.0	0.1	3.0	2.0
U.S. No. 2	54.0	0.2	5.0	3.0
U.S. No. 3	52.0	0.5	7.0	4.0
U.S. No. 4	49.0	1.0	10.0	5.0
U.S. No. 5	46.0	3.0	15.0	7.0

U.S. Sample grade is corn that:

- (a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4, or 5; or
- (b) Contains stones which have an aggregate weight in excess of 0.1 percent of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria* spp.), 2 or more castor beans (*Ricinus communis* L.), 4 or more particles of an unknown foreign substance (s) or a commonly recognized harmful or toxic substance(s), 8 or more cockleburs (*Xanthium* spp.) or similar seeds singly or in combination, or animal filth in excess of 0.20 percent in 1,000 grams; or
- (c) Has a musty, sour, or commercially objectionable foreign odor; or
- (d) Is heating or otherwise of distinctly low quality.



# U.S. Corn Grade Requirements

U.S. No.	Minimum Test Weight lbs/bu    kg/hl		Maximum Limits of		
			Damaged Kernels		
			BCFM %	Total %	Heat %
1	56.0	72.1	2.0	3.0	0.1
2	54.0	69.5	3.0	5.0	0.2
3	52.0	66.9	4.0	7.0	0.5
4	49.0	63.1	5.0	10.0	1.0
5	46.0	59.2	7.0	15.0	3.0

**For Example: If all of the factors are U.S. No. 1. except BCFM which is 4.0% or U.S. No. 3,**

**The sample would grade U.S. No. 3.**





**Official criteria factors are determined only upon request and do not affect the grade designation.**

- **Factors that are Official Criteria**
  - **Stress Cracks**
  - **Mycotoxins**
    - **Aflatoxin is a required factor for export.**
  - **Protein and Oil content**
  - **Presence of Waxy Kernels**
  - **Others**



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# Thank You!