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Texas Agricultural Extension Service

Producing Quality Wheat in Texas

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Travis D. Miller*

Texas has a history of producing quality wheat. This reputation has developed because of a number of contributing factors. Probably the greatest asset to quality wheat production is the environment in which the majority of Texas wheat is produced. A dry climate with low humidity and cool nights, coupled with supplemental irrigation to prevent drought stress, provides an ideal environment for producing a high-quality hard red winter wheat.

A second factor which has led to the widespread production of quality wheat is varietal development. University and private plant breeders have spent countless man-hours and invested their resources heavily in developing wheats that not only yield well, but produce a quality grain for the milling and baking industry.

The third step in producing a quality wheat lies with the farmer. Many of the management decisions farmers make on a day-to-day basis impact grain quality and cleanliness. The decision of major wheat buyers to purchase wheat from Texas elevators is determined largely by the quality of grain offered for sale. It is in the vital interest of all parties involved in the production and handling of wheat to offer high-quality wheat for sale.

Wheat is unique among grain crops because of the properties of proteins in flour. Upon mixing and hydration, proteins in flour form gluten which effectively traps carbon dioxide bubbles rising from the yeast fermentation process, giving the dough strength and the ability to "rise" several times in volume when compared to the volume of products initially included in the mix. The amount and physical properties of the gluten within wheat have a significant impact on usage and perceived "quality" of wheat. Gluten quality is affected by genetics and the environment in which the wheat is produced.

The protein content and gluten quality determine a wheat's usefulness for a wide variety of products. Soft wheats with relatively low protein and weak gluten strength are used for cakes, cookies and various pastry needs. Durum wheats are used to produce semolina for pasta production. As a rule, gluten strength of durum semolina is somewhat lower than the flour of comparably grown hard red spring wheat. Hard wheats, which ideally have strong gluten and a high protein content, are primarily used for bread baking. Each class of wheat has desirable properties required for a particular baking operation.

Two basic requirements exist for any wheat before it is acceptable in the commercial marketing channels. Wheats need adequate milling properties so that they can be efficiently and economically converted to flour. They also must have physical and chemical properties to produce a quality end product, whether it is bread, pastry, pasta or other products in which wheat is used.

Bread wheats must have a hard kernel and physical and chemical properties which result in a high flour yield and good mixing and baking characteristics. Various types of bread have slightly different needs with respect to flour characteristics, but most of these differences can be accommodated by blending wheats to produce specific flours for the baking industry. As hard red winter wheat comprises well over 90 percent of the planted acres in Texas, most growers should be concerned with practices and varieties which produce quality wheat for bread production and acceptable yields of grain and forage under their growing conditions.

Soft red winter wheat quality is defined by the milling properties common to the pastry industry. Bakery performance is measured in cookie and cake quality tests. An acceptable soft red winter wheat yields a flour with lower protein, lower gluten strength and softer milling characteristics than is typical of hard red winter wheats. Soft red winter varieties are not interchangeable with hard red winter or hard red spring varieties. A substitution of these market classes results in poor quality end products, and inefficient conversion of grain to flour. Soft red winter wheat flour produces a cake with tender crumb properties. The use of hard

*Extension agronomist, The Texas A&M University System.

wheat flour, with its higher protein and stronger gluten, produces cakes with a harsh texture and poor eating properties.

Market classes of wheat uncommon to Texas include the white wheats, which generally have soft milling properties and low protein. Much of the soft white wheat crop is exported to the Pacific Rim for use in oriental noodles. The bran of white wheat has recently experienced increased demand for use in high-fiber breakfast foods. White wheats are primarily produced in the Pacific northwest and to a limited degree in the northeast. Subclasses of white wheat include soft white, hard white, western white and white club.

Considerable interest currently exists in developing hard white wheats as a specialty crop for production in the drier areas of the Great Plains hard wheat belt. The color of wheat kernels is controlled by three genes. When all three dominant genes are present, the kernel assumes a dark red coloration. With the removal of each successive gene, a lighter color is assumed. Breeders are evaluating lines with essentially all of the properties of current hard red varieties but with a white kernel color. These wheats will eventually be marketed to produce superior whole wheat products but will of necessity be kept out of the red wheat marketing channels.

Durum wheats are primarily spring wheats which are milled for semolina. Semolina is a coarsely ground middlings stock from which macaroni and other pasta products are made. Good quality durum wheats have a deep amber or golden color and a high protein content. Subclasses of durum wheats are hard amber durum, amber durum and durum. Production of durum is confined to the northern Great Plains and to a limited degree in Arizona and California.

Quality wheat production begins with varietal development. Wheat quality is an important consideration in most breeding programs. Although most wheats are selected for characteristics such as yield, pest resistance, straw strength, etc., preliminary small-scale quality tests generally are made in the second or third year of development. Extensive milling and baking tests are conducted prior to release. A commercial wheat variety requires 6 to 10 years to develop after the initial cross is made. Quality determinations are made long before the potential release. If a potential variety fails to meet acceptable criteria in milling and baking tests at any stage in varietal development, the breeder usually drops the line before investing more money and man-hours in its development.

Grain hardness and the properties related to it, including many of the desired milling characteristics, are highly heritable. Protein content is not as heritable and, as a result, mixing and baking properties related to protein content are not readily altered by plant breeding. Several quality characteristics appear to have complex inheritance properties involving the manipulation of several chromosomes. These characteristics are influenced by environment as well as heredity. Such properties include loaf volume, water absorption by flour and some mixing properties.

Market Class/Varietal Selection

Perhaps the first consideration in producing quality wheat is varietal selection. The grower should be certain that the variety or hybrid selected represents the market class which he is trying to sell. Major economic losses occur when wheat classes are mixed. If a bulk container has less than 90 percent of one market class and more than 10 percent of another, (i.e., a truck load of soft red winter wheat is blended with a bin of hard red winter wheat) the lot is classified as "mixed wheat" and will be docked so that the price received is less than either class when sold alone. Each 1 percent of a contrasting market class blended into a lot of wheat will reduce the grade one point. Wheats with 3.1 to 10 percent mixing are either U.S. number 4 or U.S. number 5 grade. Table 1 details standards for the U.S. wheat grading system.

Growers should make serious marketing decisions before producing a class of wheat not commonly grown in a region, as most local elevators do not have separate handling facilities for more than one market class of wheat. This situation may develop when an awnless soft red winter wheat is produced for forage in an area dominated by hard red winter wheats. When livestock grazing the soft wheat are moved early and conditions favor good wheat grain yields, producers are likely to harvest the resulting grain crop and sell it to the local elevator. In doing so, the two market classes are blended and a wheat which cannot be successfully used for bread or pastries results. In lieu of selling to the local elevator, the grower should use this wheat as feed wheat, or seek a soft red winter market somewhere in east Texas.

Although most wheat varieties which are planted in Texas have adequate milling and baking properties for their respective end uses, there are some recognized differences between cultivars with respect to gluten strength and milling properties. If the goal is to produce high-quality wheat for a specialty market, carefully evaluate the genetic contributions of the varieties available for the market class in question. In some regions of the country, millers and bakers offer a premium price for high protein and high test weight. Flour from these high-quality wheats can in turn be used for specialty products which require an exceptionally high-quality flour, or this grain can be blended with lower quality wheat, often purchased at a discount, to bring the quality of the overall blend up to the standard level required by a baker.

In hard red winter and hard red spring wheats, varieties with strong gluten and high flour yield are actively sought by the milling and baking industry.

Table 1. Grades and grade requirements of wheat except mixed wheat.

	Minimum limits of —		Maximum limits of —						
	Test weight per bushel		Damaged kernels					Wheat of other classes	
	Hard red spring wheat or white club wheat[1] (pounds)	All other classes and subclasses (pounds)	Heat-damaged kernels (percent)	Total[2] (percent)	Foreign material (percent)	Shrunken and broken kernels (percent)	Defects[3] (percent)	Contrasting classes (percent)	Total[5] (percent)
U.S. No. 1	58.0	60.0	0.2	2.0	0.5	3.0	3.0	1.0	3.0
U.S. No. 2	57.0	58.0	0.2	4.0	1.0	5.0	5.0	2.0	5.0
U.S. No. 3	55.0	56.0	0.5	7.0	2.0	8.0	8.0	3.0	10.0
U.S. No. 4	53.0	54.0	1.0	10.0	3.0	12.0	12.0	10.0	10.0
U.S. No. 5	50.0	51.0	3.0	15.0	5.0	20.0	20.0	10.0	10.0

U.S. Sample grade

U.S. Sample grade is wheat that:

(a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4 or 5; or

(b) Contains 32 or more insect-damaged kernels per 100 grams of wheat; or

(c) Contains eight or more stones or any number of stones which have an aggregate weight in excess of 0.2 percent of the sample weight, two or more pieces of glass, three or more crotalaria seeds (*Crotalaria spp.),* two or more castor beans (*Ricinus communis L.*), four or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), two or more rodent pellets, bird droppings or equivalent quantity of other animal filth per 1,000 grams of wheat; or

(d) Has a musty, sour or commercially objectionable foreign odor (except smut or garlic odor); or

(e) Is heating or otherwise of distinctly low quality.

[1] These requirements also apply when **hard red spring wheat** or **wheat club wheat** predominate in a sample of **mixed wheat.**

[2] Includes heat-damaged kernels.

[3] Defects include damaged kernels (total), foreign material and shrunken and broken kernels. The sum of these three factors may not exceed the limit for defects for each numerical grade.

[4] Unclassed wheat of any grade may contain not more than 10.0 percent wheat of other classes.

[5] Includes contrasting classes.

Table 2 compares the quality and flour yield of several hard red winter wheats. There are a number of other wheats with strong gluten and acceptable flour yield which are now reaching the market. Because of the current pricing structure, growers cannot afford to base varietal selection solely on genetically related quality parameters. Yield potential, straw strength, maturity, pest resistance and forage potential all affect varietal selection. In the case where other properties are similar, the selection of a wheat based on good milling and baking properties is a sound decision which will impact quality and marketability in the long run.

Growers should plant more than one variety of wheat, as environmental factors such as spring freezes, hot dry weather, late or early rains during grain fill or rain at harvest time may reduce quality of wheats of one particular maturity range, but have a lesser effect on earlier or later maturing cultivars.

Fertility

Protein content is known to be inversely related to yield. Conditions which favor high wheat yields will often result in lower grain protein levels. This relationship may be altered somewhat by manipulating nitrogen fertility applications. Grain yield response to applied nitrogen is greatest when applied between planting and jointing, or spike initiation.

Nitrogen applications made after jointing have a lesser influence on grain yield and a greater influence on grain protein content. Nitrogen applications made as late as head emergence increase grain protein content by 2 to 3 percent but have little effect on yield. As nitrogen is the key building block for proteins, an adequate nitrogen fertility program is essential for producing high-quality, high-protein grain. Topdress applications near jointing usually increase both yield and grain quality.

Table 2. Quality and flour yield ratings of selected hard red winter wheat varieties.[1]

Source	Variety	Quality index[2]	Flour yield[3]
Texas A&M	Tascosa	2.8	3.6
Unknown	Red Chief	9.0	4.5
Texas A&M	Sturdy	2.8	3.4
Oklahoma	Triumph 64	5.3	0.7
Nebraska	Scout 66	3.4	3.2
Kansas	Eagle	2.7	2.5
Kansas	Larned	4.2	3.3
Colorado	Vona	4.9	6.5
Kansas	Newton	3.6	8.0
Nebraska	Centurk 78	3.1	7.1
Kansas	Arkan	2.2	2.7
Nebraska	Brule	4.0	5.5
NAPB	Hawk	2.8	5.6
Oklahoma	Chisholm	2.0	2.7
NAPB	Mustang	3.5	1.1
Nebraska	Siouxland	5.1	1.8
NAPB	Stallion	2.9	6.4
Texas A&M	TAM W 101	2.8	3.5
Texas A&M	TAM 105	3.0	4.9
Texas A&M	TAM 106	2.8	7.0
Texas A&M	TAM 107	2.8	4.9
Texas A&M	TAM 108	5.4	6.5
Texas A&M	TAM 200	0.4	6.5
NAPB	Victory	5.9	4.7
Kansas	Dodge	2.0	6.4
Oklahoma	Century	2.9	9.0

[1] This table was adapted in part from unpublished data of T.S. Cox, M.D. Shogren, R.G. Sears, T.J. Martin, and L.C. Bolte, Department of Agronomy, Kansas State University and USDA-ARS Grain Marketing Research Labortory, Manhattan, Kansas.

[2] Quality index is a rating scale of 0 to 9. This value is a summation of flour protein, adjusted mixing time, adjusted loaf volume and crumb grain score. The scale ranks varieties so that 0 is the highest quality and 9.0 is the poorest quality.

[3] Flour yield is a rating scale of 0 to 9 so that cultivars with a 0 consistently produce highest flour yields and those with a 9.0 consistently produce the lowest flour yields.

Producers need to evaluate the cost and benefit of producing high-protein grain. Some varieties with exceptionally high protein consistently sacrifice yield. Excess nitrogen applications with the goal of a high protein content can only be justified if protein premiums are available. Some specialty markets are willing to pay premiums adequate to compensate growers for extra expense involved in producing exceptional quality wheat. In this case, a wheat grower might be able to justify high-quality wheat as a specialty crop in which several extra management steps are necessary to produce an exceptional product. These growers should seek contracts ensuring a fair payment for their extra production costs.

Heat and drought stress during grain fill are an annual occurrence in Texas. Wheat makes excellent use of stored soil moisture, and many crops are largely produced on stored moisture. Prolonged stress during grain fill causes small seed size. Extreme stress can cause a shriveled seed coat, which is a factor in grade. Shriveled grain is frequently low in test weight and produces low flour yields. Land preparation activities which produce a hardpan reduce the ability of wheat roots to use stored moisture. Using chisels or other primary tillage tools to shatter hardpans between growing seasons improves water use efficiency and reduces stress on developing wheat. Avoid the use of disk harrows after primary tillage, particularly in wet soil conditions, as disks are a major source of soil compaction and resulting water stress. Excessive seeding rates reduce water use efficiency. Seeding rates in excess of 1.2 to 1.3 pounds of planted seed (15,000 to 17,000 seed per acre) per bushel of yield may result in production of large numbers of sterile tillers which consume water, but do not contribute yield. In environments where drought stress is a major yield-limiting factor, conservative seeding rates will improve grain quality.

Plant diseases, particularly the rusts and septoria, are perennial problems which cause shriveled grain. These organisms have no direct effect on the developing seed, but reduce the photosynthate transferred to the grain. The damage is a function of destroyed leaf area attributable to the disease. If the leaf area is destroyed during grain fill this stage is not completed, causing the shriveled seed appearance. Fungal diseases such as leaf rust and septoria can be controlled by timely fungicide applications.

A carefully managed fertility program is another means of improving water use efficiency. Well-fertilized wheat is up to twice as efficient in water use as unfertilized wheat and has correspondingly higher grain quality, both in protein content and seed fill. Heavy nitrogen fertilization at plant or preplant on ungrazed wheat will result in excessive vegetative growth, which increases susceptibility to freeze injury, enhances lodging potential and reduces water use efficiency. Levels of preplant nitrogen which can be applied without excessive lodging vary with planting date, straw stength of a particular variety and winter weather conditions. Wheat which emerges shortly before the onset of prolonged cool weather conditions can tolerate high levels of fall-applied nitrogen. Wheat with a genetically weak straw which is planted very early will lodge at relatively low fall-applied nitrogen rates. A split or preplant application plus a topdress nitrogen application before jointing reduces fall and winter growth, improves yield and enhances grain quality.

Freezing weather during grain fill is a serious problem which causes shriveled seed. Little can be done to prevent freeze injury other than avoiding early planting dates and planting wheats of more than one maturity, which spreads the risk over a longer period.

Weed control is important in improving water use efficiency. Good seedbed preparation and early use of effective herbicides can eliminate stresses imposed on the crop by weed population.

Foreign Matter in Grain

Contaminated wheat occurs when foreign matter is gathered during harvest or from careless handling, unclean storage facilities or pests such as insects, birds and rodents. The primary source of foreign matter at harvest consists of weeds and weed seed. Harvesting wheat with green weeds in the field increases moisture content and introduces weed seed and weed fragments into the harvested grain. The best solution to this problem lies in early scouting and careful attention to weed control either at planting or shortly after weed emergence. When weeds grow through the wheat canopy, control alternatives are limited. Phenoxy herbicides such as 2,4-D can be used after the soft dough stage to dry broadleaf weeds before the grain is ready to harvest. No desiccant is currently labeled for Texas wheat. Rapidly dry wheat harvested from weedy fields, if needed, and clean to remove foreign material. Consult your county Extension agent for information on weed control in wheat.

A last choice solution for drying down weeds in wheat without the application of a desiccant involves cutting wheat in swaths and harvesting after the swaths dry down to acceptable moisture contents. In any case, preventative weed control is superior to and less expensive than salvage operations after weeds become large and competitive.

Lodging in wheat can cause the introduction of dirt, stones and other foreign matter into the wheat during the harvest operation since headers are lowered to reduce grain loss. Lodged wheat also is more prone to sprout in the head, as many of the heads come into contact with moist soils. Steps to reduce lodging include:

- Select varieties with strong straw.

- Shorten wheat height by grazing.
- Use careful nitrogen management. A single nitrogen application will result in more lodging than will split nitrogen applications. Apply a higher percentage of the total nitrogen at jointing if weak-strawed varieties are used.
- Harvest promptly as wheat dries to acceptable moisture levels. Wheat straw decays rapidly after drying down.

Carefully clean combines and storage facilities to prevent foreign matter in grain. This includes removing seed of other crops and wheat of other marketing classes.

Fungal Organisms

Contamination of wheat seed by fungal organisms occurs either in the field or during storage. Use of an approved systemic seed treatment at planting greatly reduces contamination from smut. Use of seed treatments and a sound rotation program of wheat with other crops minimizes contamination from the organism that causes black tip (*Helminthosporium* spp.). Do not plant seed with a high level of black tip damage.

Fungal organisms which spread in stored grain are entirely different from those which cause plant disease in the field. Almost without exception, fungal organisms which grow in stored wheat can be prevented by storing clean grain at a moisture content of 13 percent or below in properly designed and well-maintained structures. Carefully clean and inspect storage structures prior to use.

Weedy and trashy wheat may develop hot spots that can spread fungi. Poorly designed grain bins or inadequate aeration of stored grain can result in moisture condensation during major changes in air temperature. Moisture accumulation from improper handling of stored grain invites damage from stored grain fungi and insects. These fungi cause numerous wheat quality problems including loss of germination, discolored germs, mustiness, spoilage, heating and bin fires.

Insects

Wheat quality is affected considerably more by stored grain insects than by insect activity before harvest. Stress caused by aphids late in the growing season inhibits grain fill and causes some kernels to shrivel. Stored grain insects, however, can reduce high-quality grain to an unmarketable product. Variables which a producer can use to reduce stored grain insects include:

- Set combines to minimize cracking and breakage. Floury dust and broken kernels enhance insect reproduction.
- Keep stored wheat cool and dry. A moisture content below 11 percent severely curtails the ability of several grain pests to reproduce. Take advantage of cooler periods (air temperature 20° below grain temperature) following harvest to aerate grain, reducing the temperature of the grain mass. Most stored grain insects reproduce best at high temperatures (85° to 90°F). Cooling and drying also can be accomplished by circulating stored grain between tanks on a dry day.
- Use appropriate stored grain insecticides and/or fumigants. Consult Extension publication B-1410, *Suggestions for Controlling Insects in Farm Stored Grain*, or contact your county Extension agent for more information on stored grain insects.

Controlling insects in stored grain is imperative. New federal guidelines for grain grading (May 1988) are 30 times more restrictive on weevil damage than old standards. Most millers now X-ray all grain samples to detect hidden insect damage and will not accept grain with serious damage. Grain is now classed as sample grade if more than 32 kernels per 100 grams, or about 1 percent, are damaged by insects.

Sprouted and Weather Damaged Grain

Wheat harvest in the Blackland Prairie and east Texas occurs during a seasonally wet period of the year. Wheat is frequently weathered by rainfall near ripening, and sprouting of grain in the head occasionally occurs. Sprouting is generally inhibited by natural dormancy in wheat until the grain moisture content has dried to around 14 percent. If rains occur after maturity but before wheat dries below 14 percent, bleaching or weathering occurs, but little sprouting results. Prolonged wet periods after wheat has reached harvest moisture result in sprouted wheat, which is of some value as a feed grain but is of greatly reduced value as a source for flour or seed. Bleached color, however, does not necessarily mean grain quality is low. Recent studies have found little correlation between protein content and grain color.

The best management practices for avoiding weather damage in wheat include planting wheat of more than one maturity date and promptly harvesting when grain moisture is below 13.5 percent. This may require skipping low spots or unripe areas for later cutting. Staggered maturity dates allow more efficient use of harvest equipment, preventing long intervals between maturity and the harvest operation.

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