NEBRASKA WHEAT

Nebraska Wheat

Quality Assurance Report

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On behalf of the wheat farmers of Nebraska, I appreciate the opportunity to provide you our insight on wheat production and give you greater understanding on the importance we place on the quality of Nebraska's food, feed and fiber.

The wheat industry is a melting pot of people, cultures and traditions. Experiencing this aspect of the industry has been one of the most exciting parts of my position as Executive Director of the Nebraska Wheat Board. I've enjoyed working with so many producers, buyers, millers, bakers and educators.

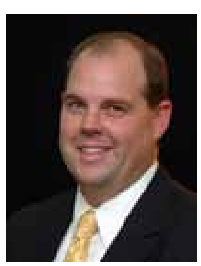
We believe that Nebraska Wheat is a consistent, versatile and reliable choice. Our producers are dedicated to raising quality wheat for their families and yours. You will find proof of our belief in this report. The Nebraska Wheat Quality Assurance Report includes information about Nebraska Wheat from the development of seed, to the processes and technology used in production, to the tests run after harvest. This report details what producers and researchers do to develop a quality crop and why they do it. I encourage you to use this report to learn more about Nebraska Wheat and how it's produced.

If you have any questions about this report or Nebraska Wheat, please contact the Nebraska Wheat Board office. To stay current with the latest news and information about Nebraska Wheat, or to view the weekly crop report, visit our website at www.nebraskawheat.com.

On behalf of the Nebraska Wheat Board and Nebraska's wheat producers, thank you for looking at Nebraska wheat – and please, never hesitate to ask for our help.

Sincerely,

Royce Schaneman, Executive Director
Nebraska Wheat Board



Nebraska Wheat Facts

- Nebraska raises between 70 and 80 million bushels of wheat annually
- 99 percent of the crop is Hard Red Winter wheat and 1 percent is Hard White wheat
- 50 percent of Nebraska's wheat is exported
- Approximately 8,037 farms in the state include wheat
- Approximately 76 businesses in 26 counties handle wheat in a milling or processing format
- The 76 businesses employ more than 4,300 people in Nebraska
- Nebraska plants between 1.5 and 2 million acres of wheat annually
- The average yield is 44 bu/acre dryland and 62 bu/acre irrigated
- Production value of the wheat crop ranges from $375,000,000 to $450,000,000
- Nebraska is one of the top ten HRW wheat producing states in the nation

Wheat and the Foods You Eat

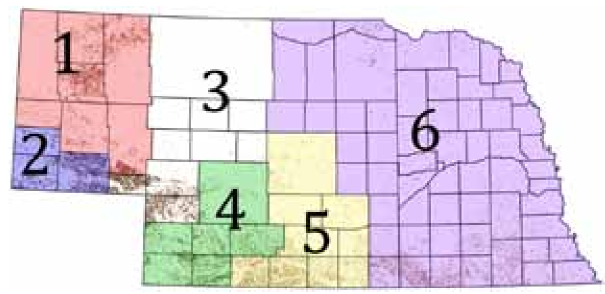
The USDA's Food Pyramid recommends half of all grain intake should consist of whole grains. Whole wheat is an excellent source of dietary fiber. Fiber acts like a broom and helps clean out the digestive tract while satisfying the appetite for a longer period of time. One slice of whole wheat bread contains 2 grams of dietary fiber and one ounce of wheat bran cereal can contain as much as 9 grams of dietary fiber.

Wheat is one of the most important foods in a balanced diet. It's primarily made up of complex carbohydrates which provide a source of time-released energy.

Introduction

The Nebraska Wheat Board

The Nebraska Wheat Board (NWB) consists of a seven-member Board of Directors made up of wheat producers. Board members represent one of six districts or an at-large district. NWB works to increase consumption of wheat and wheat food products and to develop and maintain domestic and export markets for the Nebraska wheat producer by investing check-off funds and participating in research, education, promotion and marketing. Check-off funds come from a self-imposed tax called the wheat excise tax. Each bushel of wheat marketed in Nebraska is assessed a $0.0125 bushel tax at the point of first sale.



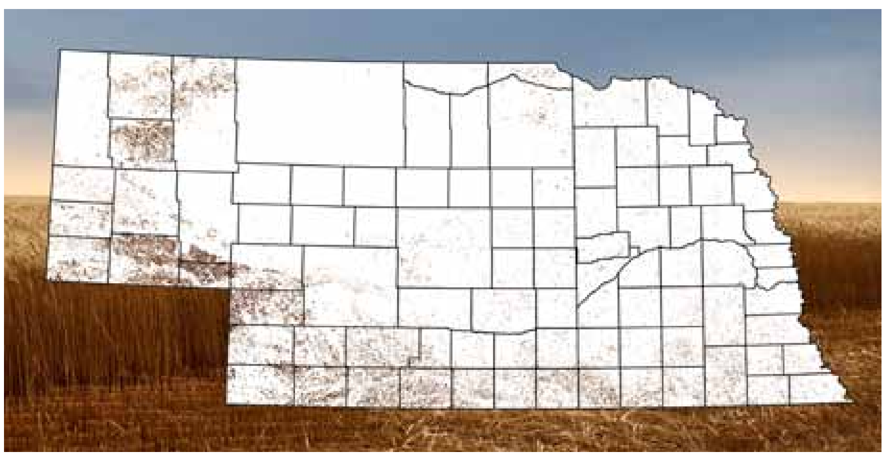
The Nebraska Wheat Growers Association

The goal of the Nebraska Wheat Growers Association (NWGA) is to improve and stabilize the profitability of the Nebraska wheat producer. To achieve this goal, NWGA specializes in state affairs, international policy, disaster relief programs, research, environmental policy and domestic policy. NWGA is governed by a five-member Executive Board consisting of four officers and an executive director. The board's role is to develop policy, direct the organization and, most importantly, know and represent the interests of Nebraska's wheat growers. NWGA is part of the National Association of Wheat Growers (NAWG). This organization works to advance the wheat industry at state and national levels. NAWG is in daily communication with state associations as well as members of Congress, the USDA and other government agencies.

Introduction

Nebraska is quite diverse in geography. A drive across the state unveils rolling hills, fertile valleys and level plains in the east, Sandhills in central Nebraska and high plains in the west. Wheat was the first crop grown in Nebraska. However, use of the Ogallala Aquifer, a massive underground reservoir, for irrigation combined with the fact that most of the state's soil is suitable, has made corn and soybeans predominant crops.

The Sandhills is well suited for pasture grasses and hay operations. But dryland soils in the southwest and Panhandle regions have continually kept them as prime ground for wheat production. As a result, most wheat fields in Nebraska are concentrated in the northwest, southwest and south central parts of the state, with a few fields in the southeast (as indicated on the map at center).



Shaded areas indicate wheat growing locations in the state. *Map courtesy of USDA Nebraska Agricultural Statistics Survey*

Six classes of wheat are raised in the U.S.: Durum, Hard Red Winter, Hard Red Spring, Soft Red Winter, Hard White and Soft White wheat. Nebraska's wheat producers primarily raise two of these: Hard Red Winter (HRW) and Hard White Winter (HWW).

HRW wheat is known for its excellent milling and baking characteristics, making it popular wheat for bread flour. It has a high level of **protein** and is used in breads, rolls and other yeast-raised flour foods. HWW wheat is the newest class of wheat to be raised in the United States. It has similar milling and baking qualities as HRW, but with a sweeter, milder flavor. It's used in the same products as HRW as well as oriental noodles, flat breads and tortillas.

Producers raise HRW and HWW because the hard wheat varieties grow well with limited rainfall and low humidity areas. Also, the extreme summer temperatures in Nebraska make most of the state unsuitable for spring wheat varieties.

Unlike corn or soybeans which are planted in the spring, wheat in Nebraska is sown during the fall, usually starting in September. The wheat grows until it reaches **vernalization**. During this state the wheat must submit to a certain amount of cool temperatures (between 40°F and 50°F) before it **joints** and **flowers**. Because soil holds a certain amount of cold or warmth after air temperatures change, producers often desire a layer of snow to act as insulation between the soil and air. In the spring, when the crown temperatures rise above 48°F, winter wheat dehardens and resumes its growth. These processes will be covered in greater depth later.

The suitability of HRW and HWW wheats to Nebraska has kept the state a consistent top-ten wheat producer. In 2009 alone, the wheat production of 76.8 million bushels was valued at more than $375 million.

Wheat is one of the staple foods in human diets. Nebraska wheat's consistent quality puts it in demand with millers around the globe. Approximately half of Nebraska's wheat is exported annually. The majority of exports leave through ports in the Pacific Northwest or through the Gulf of Mexico.

Seed Research

To ensure consumers receive the best possible product, Nebraska wheat works for quality from the beginning with the seed. To this end, NWB invests check-off funds in wheat research. Investments may vary from funding studies for particular scientists associated with the University of Nebraska-Lincoln (UNL) to funding facilities like the UNL seed quality lab.*

Before the seed varieties producers purchase become available, they undergo thorough testing to ensure successful growth within the state. These tests span a minimum of 12 years. Some characteristics wheat is often evaluated for include: winter hardiness, agronomic performance, disease resistance and end-use quality. Improvement in at least one area must be evident before the wheat is considered for release.

If wheat passes all tests until the sixth generation it will undergo quality testing at the UNL seed quality lab. If the wheat passes all initial tests, the seventh generation will undergo full scale milling and test baking evaluations. This process lasts for five years as milling and testing is completed on five consecutive generations.

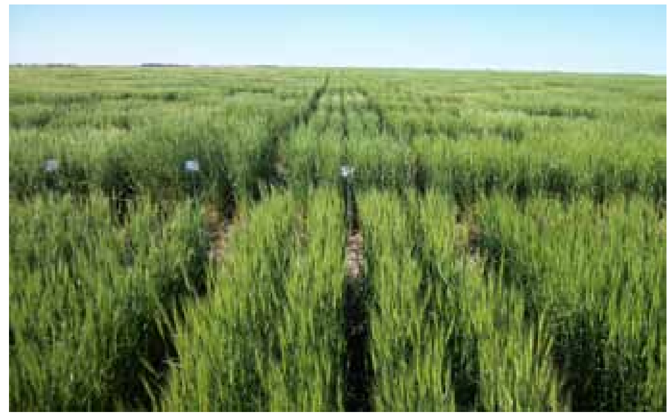
If the wheat passes all tests up to the eleventh generation, it is sent to the Wheat Quality Council for quality evaluation by the industry before release.

Also, if the wheat is successful to the eleventh generation, it's sent to one, two or three of the major U.S. millers: ConAgra, ADM or Cargill.

No release of a new variety will occur at any time before the twelfth generation, and then only after full evaluation. By this point, wheat will have completed six years of replicated statewide testing and three years of replicated state variety trials and have undergone full scale milling and test baking evaluations.

Based on the previous information, promising strains from the university are sent to the Small Grains Variety release Committee. The committee recommends to UNL's dean of research whether the new wheat lines should be formally released to the public.**

*To learn more about research and facilities at UNL, see the virtual greenhouse tour and breeding tutorial in our video gallery at www.nebraskawheat.com.



Multiple varieties of research wheat grow in designated test plots in one of UNL's wheat research fields. *Photo by P.S. Baenziger, UNL*

Levels of Testing

Statewide Testing: Testing performed by UNL breeders and scientists at nine designated locations across Nebraska.

State Variety Trials: Public trials where outside personnel raise and evaluate wheat to eliminate chance of bias by the breeder. All information from these trials is publicly available.

USDA Regional Trials: Program where other state nurseries evaluate Nebraska's varieties in their nurseries. The process is reciprocated between several states.

Inclusive Research Practices

Wheat researchers and breeders at UNL try to be inclusive in all research. Because Nebraska's geography varies greatly, scientists work on some varieties that are particular for areas of the state as well as varieties that may be acceptable statewide. Research focuses include dwarf and semi-tall wheat varieties, conventional and organic varieties, varieties that are suitable for irrigation

**Seed research information contributed by P.S. Baenziger, UNL.

Seed Research

A researcher at UNL prepares this plant for crossing by removing the anthers from the wheat head. *Photo by P.S. Baenziger, UNL*

and/or dryland and both red and white wheat.

Agronomic Performance

Agronomic performance, winter hardiness and survival tests are done within the state's extensive field testing research centers and in the USDA regional trials. Agronomic characteristics are those which have monetary value to a producer: yield, test weight, protein, lodging and disease resistance. Eventually the wheat is entered into the state variety testing effort. By the time a variety is released, it will have been tested in more than 100 environments across the region for agronomic performance and winter survival.

Disease Resistance

A variety of diseases can wreak havoc on wheat crops. Different diseases have different effects, but the end results can range from a decrease in yield or test weights to a complete crop loss.

As a result, wheat breeders around the globe focus research on developing varieties resistant to diseases in their areas. The majority of research in Nebraska is done on UNL land which is separated from most producers' fields by large distances. This reduces some of the risk of exposing commercially produced wheat to disease. Testing may include inoculating wheat plants with certain diseases either in the fields or in the greenhouse and applying fungicides developed for various diseases.***

Most commerically available wheat varieties have been screened for resistance to some of the diseases during the breeding program before release. New varieities are screened for resistance to only some of the diseases.

End-use Quality

Wheat is a staple ingredient in many foods. Therefore, it's important that the new varieties developed have more than just strong agronomic performances and disease resistance. They must also have good end-use characteristics. This means the wheat varieites deveIeloped must maintain or improve on the baking qualities of previous wheat varieties. During end-use quality tests the wheat is checked for characteristics like mix time and tolerance, flour and wheat protein and internal and external loaf characteristics.****

These wheat plants are part of the UNL wheat breeding program. They have been cross pollinated and each plant is individually tagged based on the lines being crossed. *Photo by P.S. Baenziger, UNL*

***For more on wheat diseases refer to the disease section of this report. (p. 8)

**** For more on end-use characteristics refer to the end-use qualities section of this report. (p. 11)

Diseases

Damaging diseases for wheat differ around the globe. Diseases that may be prevalent in some countries or states, may not play a factor in Nebraska. Part of this is because the disease hasn't yet made it to the region. Another factor is the conditions required to support the disease. Some diseases surivive better in specific climates than others. However, all diseases can have a potentially large impact on a wheat crop. The following are summaries of key diseases that have potential to harm Nebraska wheat. The damages each can cause are reasons why farmers invest (when applicable) in fungicides and why disease resistance conducted by wheat breeders is so important.*

Stem rust: Stem rust is a fungal disease whose primary host is wheat. The disease can cause extreme yield losses in wheat crops, up to 100 percent loss in yield and a 1/3 decrease in test weight. The disease has an appearance of dark, red-orange pustules commonly found on the leaf blades, stems and leaf sheaths of wheat plants. Occasionally it will aslo affect parts of the wheat head.Pustules are oval-shaped or elongated and are visible on both sides of the leaf blade. Because of the damage stem rust can do to a crop, wheat breeders work to develop varieties that are resistant to the disease. Resistance is evaluated in the greenhouse, the field and at the USDA Cereal Disease Lab in St. Paul, Minnesota. Varieties of wheat **endemic** to Nebraska are resistant to stem rust and are used to reduce the risk of spreading the disease. Stem rust can be effectively controlled with fungicides.

Photo by P.S. Baenziger, UNL

Stripe rust: Stripe rust, also known as yellow rust, occurs sporadically in Nebraska since 2000. It affects mainly leaf blades, but occasionally can also appear on wheat heads when the disease is very severe. Stripe rust pustules are small, round, yellow-orange in color and merge to form stripes on leaf blades. The disease is favored by cool, wet weather. Therefore, it appears early in the growing season, starting in mid to late April. It can cause yield losses of up to 40 percent or more in susceptible varieties. In 2010, stripe rust was widespread in Nebraska and caused severe yield losses in some fields planted with susceptible varieties and which were not sprayed with a fungicide to control the disease. Stripe rust is managed by applying fungicides and planting resistant **cultivars**.

Photo by P.S. Baenziger, UNL

Leaf rust: Leaf rust, also known as brown rust, occurs every year in Nebraska, but its severity varies from year to year depending on weather conditions. Round or slightly elongated orange-brown pustules occur mainly on the upper leaf surface. Leaf rust is favored by moderately warm temperatures and wet weather. In Nebraska, it appears starting in mid-May. In 2007, severe epidemics of leaf rust occurred in Nebraska. The disease can cause yield losses of up to 5 percent or more depending on cultivar susceptibility and environmental conditions. Leaf rust is managed by applying fungicides and planting resistant cultivars.

Photo by P.S. Baenziger, UNL

Tan spot: Tan spot is the most widespread leaf spot disease of wheat in Nebraska. It occurs as a complex of several leaf spot diseases including Septoria tritici blotch, Stagonospora nodorum blotch and spot blotch. Tan spot has become prevalent in the state over the last several decades due to cropping practices that leave wheat residue on the soil surface. The tan spot fungus overwinters as

* Disease information contributed by S. Wegulo, UNL.

Diseases

Photo by S. Wegulo, UNL

fruiting structures on wheat residue. In the spring those structures release spores which cause infection of lower leaves. Secondary spores form in lesions caused by initial infections and are spread by wind within and between fields, causing infections of healthy plants. Tan spot is favored by wet weather and moderate to warm temperatures. Symptoms can be manifested as **necrosis** or **chlorosis** or both. The necrosis symptom comprises spots that appear initially as tan-brown flecks and expand into lens-shaped, tan lesions with yellow borders. The chlorosis symptom consists of rapidly expanding yellow areas surrounding lesions on the leaf blades. Lesions may coalesce into large blotches as they age, predisposing leaves to premature aging. Symptoms progress from the lower leaves up the plant. If the flag leaf is severely infected, yield losses of up to 50 percent or more can result. The disease can also affect wheat heads. Symptoms on the wheat head are not easily distinguised and may include bleached or brownish glumes. Infected kernels are characterized by a reddish color on the seed coat, a disease of the seeds known as red smudge. Some cultivars developed in the UNL breeding program have resistance to tan spot.

Fusarium head blight: Fusarium head blight (FHB), also known as scab, occurs sporadically in Nebraska. Epidemics occurred in the state in the early 80s, mid 90s and late 2000s. The scab fungus prematurely bleaches wheat heads. Bleached spikelets are sterile or contain shriveled, chalky white or pink kernels referred to as *Fusarium*-damaged kernels (FDK). The fungus produces a tonxin known as deoxynivalenol (DON) in FDK or in infected but apparently healthy kernels. DON-containing grain is discounted at the elevator. The more DON in the wheat, the higher the discount. DON can pose significant health risks to humans and livestock. As a result only 5 to 10 parts per million are acceptable in animal feed and only 1 part per million is acceptible in wheat for human consumption. Losses to scab are due to reductions in yield, test weight and grain quality as well as discounts at the elevator for the presence of DON in grain. Research conducted in Nebraska and Kansas from 2007 to 2009 showed that scab caused more than 50 percent yield loss in check plots compared with plots sprayed with a fungicide to control the disease. Some newly released cultivars from the UNL wheat breeding program have moderate resistance to scab.

Photo by S. Wegulo, UNL

Soilborne mosaic virus: Wheat soilborne mosaic virus is common in eastern Nebraska. The virus survives in the soil in association with resting spores of a primitive fungus called *Polymyxa graminis*. During cool wet weather late in the fall, resping spores of the fungus germinate by forming zoospores which swim in water and infect root hairs of fall-sown wheat. Following infection, the fungus colonizes root tissues and produces more zoospores and resting spores. The zoospores transmit the virus to plants. Infection is favored by high soil moisture and soil temperatures ranging from 54^{o} to 56^{o}F. Symptoms of wheat soilborne mosiac are most prominent on early spring growth. Disease development is optimal at 61^{o}F and stops above 68^{o}F. As seasonal temperatures rise, severity of symptoms diminishes. Leaves initially show light green and yellow mosaic patterns. These

Photo by P.S. Baenziger, UNL

Diseases

Wheat at a UNL test plot is evaluated for soilborne mosaic virus. The light green plants are susceptible to the disease while the darker green plants exhibit a level of resistance.
Photo by P.S. Baenziger, UNL.

symptoms become more intense on older leaves. Infected plants often are stunted. Rosetting can occur in highly susceptible varieties. Because the fungus that transmits wheat soilborne mosaic virus is favored by wet soils, the disease is most noticeable in localized low areas in the field, along waterways or around old building sites. Yield losses of up to 20 percent or more can result from wheat soilborne mosaic depending on the level of susceptibility of the wheat cultivar planted. The only effective strategy for managing wheat soilborne mosaic is planting resistant cultivars. The wheat breeding program at UNL has developed cultivars resistant to this disease.

Wheat streak mosaic virus: Wheat streak mosaic virus (WSMV) is the most serious virus affecting wheat in Nebraska. It causes wheat streak mosaic, a disease that can result in total loss of a wheat crop in a field or in a localized area. Although the disease has been most prevalent in western Nebraska, it occurs throughout the state. It is transmitted by the wheat curl mite. Serious infetion of winter wheat occurs in early fall, but symptoms usually do not develop until spring. As spring temperatures rise, symptoms become more visible and rapidly develop when daily high temperatures first exceed 80^{o}F for a few days. Young leaves of WSMV-infected plants show a yellow mosaic pattern of parallel discontinuous streaks. As symptoms progress, the leaves become mottled yellow, and in the later stages of symptom expression, the yellowing may be very extensive. The most effective strategy for management of WSMV is controlling vounteer wheat, especially the volunteer that emerges from grain shattered by hail just before harvest. Other operational pratices like not planting too early, controlling grassy weeds and not planting next to late maturing corn fields (they can be a carrier of the mite and virus as well) may also control the spread of WSMV. In addition, Mace, a newly released (by USDA and UNL) winter wheat cultivar has good resistance to WSMV.

Photo by S. Wegulo, UNL

End-Use Qualities

End-use quality testing goes beyond evaluating the wheat kernels. During these tests scientists examine flour made from the wheat and bread made from the flour. These tests are important because wheat is primarily used in food products, and as a result, wheat varieties must perform well under food processing conditions.

Wheat & Milling Characteristics

These characteristics indicate milling efficiency and functionality.

- **Single-Kernal Characteriztion System** is the process of individually analyzing 300 kernels for their weight, diameter adn omisture content, as well as kernel hardness. These characteristics affect milling conditions like tempering or roll gap settings. Researchers generally look for varieties with a diameter greater than 2.4 mm and a kernel weight greater than 30 mg.
- **Flour yield** is the percent of the wheat kernel that can be milled. Millers use this to determine the profitability of wheat varieites. Wheat samples are cleaned and run through a mill. The flour and non flour components (bran and shorts) are evaluated. And ideal extraction rate on a Buhler mill usually ranges between 70 and 75 percent.
- **Flour ash** is the inorganic (unburnable) material within the bran layer. It’s usually expressed as a percentage of the inistial sample weight. Ash can affect the color of flour and therefore the color of products. Some products which need to be extremely white, may use a flour with a lower ash content. Ash content also indirectly reveals the amount of bran contamination in flour, which is an indication of milling efficiency.
- **Falling number** indicates the level of enzyme activity. A high number means little activity and the wheat is usually good. A low number indicates more activity and possible sprout damage. Because yeast needs some sugar to develop, some enzyme activity is needed. However, too much activity can result in sticky doughs and poor final product textures. Flour with a high falling number can have enzymes added to compensate. However, flour with too low a falling number is generally unusable.
- **Wet Gluten** is an analysis of the quality and quantity of gluten in wheat. Gluten is responsible for the elastic characteristics of dough. Wet gluten is tested for by washing the flour sample with a salt solution. This removes the starch and other solubles so only wet gluten remains. The amount of gluten is evaluated on a gluten index and is an indicator of gluten strength.

A Wheat Quality Lab employee carefully pours a 50-gram sample of wheat that’s been milled into its labeled jar to be used for further testing. *Photo by Caroline Brauer*

Flour & Dough Characteristics

Farinographs, alveographs and mixographs test flour’s dough and gluten properties. These indicate dough strength, processing requirements and are a good indication of final product textures.

- **Arrival time** indicates the rate (in minutes) that water is absorbed by flour.
- **Departure time** is when the dough begins to break down. Departure time is measured in minutes and indicates dough’s consistency during processing.
- **Stability time** measures the difference between arrival

and departure time (expressed in minutes) and is an indication of dough strength. Weaker gluten flours have shorter stability times.

The use of computers and electronic equipment helps researchers at UNL's Wheat Quality Lab obtain more precise and accurate data on wheat tests. *Photo by Caroline Brauer*

- **Absorption** is the amount of water needed for flour to be processed into an optimal finished product. Weak gluten has lower water absoption levels. This characteristic is important to bakers because it describes how much water can be added to certain flours.
- **Stability** measures (in minutes) the amount of time dough will maintain maximum consistency. Wheats with stronger gluten and higher water absorption usually have longer stability.
- **Peak time** is the length of time (in minutes) it takes for dough to develop and reach maximum consistency starting when water is added. Peak time is an indicator of dough's optimum mix time. Weak gluten flours tend ot have shorter peak times.
- **Mixing tolerance** is a measurment of how well dough withstands continued mixing. It's a good indicator of how the wheat will respond to overmixing. Strong gluten flours tend to have more mixing tolerance.
- **Extensibility** is the elasticity of dough, how well it will stretch without breaking.
- **Alveographs** test the amount of force needed to break a dough bubble. This test is important to millers who use it to determine dough strength and thus the potential consistency of a product. Weak gluten flours are often used in cakes, and strong gluten flours are more often baked into breads.

Baking Characteristics

During baking tests, scientists often evaluate the volume of loaves and the internal structure (appearance, crumb size and crumb color). Different labs have different characteristics that are looked for during these evaluations. Often digital image analyzers are used to examine crumb and internal characteristics. The overall purpose is to ensure that the flour milled from the wheat can produce consistent products that meet consumer expectations regarding appearance and texture.

This large oven is separated into mini compartments and is capable of baking multiple loaves of different sizes for testing within the lab. *Photo by Caroline Brauer*

Certified Seed

When planting, producers usually obtain seed from one of two sources: they use their own seed saved from harvest the year before or they purchase certified seed raised by certified seed producers. A certified seed producer is an on-farm seed professional who produces high quality seed that's been certified according to the standards set forth by the Nebraska Crop Improvement Association (NCIA). All certified seed producers must be members of the association. In joining the association, producers agree to comply with all certification prodecures, the Nebraska Seed Law and Federal Seed Act requirements. NCIA has the right to place any producer on probation or eliminate eligibility as a certified seed producer should the producer violate regulations.

Certified seed is often sold in bulk bags like this one. *Photo courtesy of UNL ARD*

Certified seed producers start by selecting a variety that will produce well in their area. According to NCIA standards, certified seed producers are required to provide NCIA with complete verification of the source, class and quantity (pounds or bushels) of the seed they choose to produce as certified seed. Choosing the seed represents a potentially high-risk investment for certified seed producers. Because they're raising the seed other producers will use to produce market wheat, certified seed producers have to plant, nearly two years in advance, the wheat varieties they think other producers will want to raise. If a certified seed producer raises a seed wheat that nobody wants to buy, the loss comes out of their own pocket.

Certified seed producers obtain their seed from the source desired and plant it. Common sources for Nebraska's certified seed producers includeHusker Genetics (also known as the University of Nebraska Foundation Seed) and private companies. Producers then must apply for field inspection and pay the associated fees. (Fees cover the cost of administering the program and providing needed field and record keeping services.)

Field Inspection

Fields are examined for varietal purity and disease and weed control. An NCIA representative makes at least one inspection per field. Purity is determined by using a sequential sampling procedure.

However, before fields are inspected they must be **rogued** for plants which don't belong and producers must show that they've taken precautions to eliminate potential contaminating crops or weeds. All fields must also meet isolation and land requirements as set forth by the NCIA. Applicants receive a copy of the report after the inspection is complete.

Isolation and Land Requirements

- Producers must clearly define the areas to be inspected with at least a five-foot boundary which is mowed, uncropped or planted to a different type of crop

- Producers cannot have planted the field to another variety of the same kind within the last growing season. (This is except when a seed crop of the same variety has been grown from a seed of an equal or higher class and the field was approved for certification.)

Seed Conditioning

Should fields pass inspection and be harvested, the seed must complete another step before being marketable. All certified seed must be conditioned by an approved facility. Approved facilities are those which can process seed without introducing mixtures, don't handle rye or triticale with the same equipment, maintain seed identity continuously, maintain complete records on all operations and allow inspection by the certifying agency. The overall purpose of seed conditioning is to ensure seeds are uniform in size and that no seeds of other crops, noxious weeds or other weeds are in the wheat seed.

Maintaining Seed Quality

Certified seed producers must maintain accurate and detailed records of all certified seed throughout the production, conditioning and marketing processes. All records must be provided to NCIA should they be requested. Records should include identification (variety of seed and bin number) for all bins storing bulk certified seed, as well as a representative sample of each lot of seed that's for sale.

Conditioning Facility Requirements

The following are equipment requirements all facilities must meet to be approved for conditioning certified seed, as detailed in the NCIA's guide*, "General Seed Certification Standards." All facilities are subject to annual approval.

1. An air-screen cleaner with: a minimum three screens, equipped with traveling brushes, roller or ball racks beneath the screens capable of dislodging any embedded material, and a combination of at least two variable air blasts or vacuum pickups. The other option for air-screen cleaners includes: an air-screen cleaner with two screens, equiped with traveling brushes, roller or ball racks beneath the screens capable of dislodging any embedded material, and at least one variable air blast or vacuum pickup. This setup also requires spirals and/or a gravity separator, a length grader or other finishing equipment.
2. A selection of screens in good condition with the appropriate perforations.
3. Secondary finishing equipment (spirals, gravity separator, length grader and velvet roller) is recommended.
4. A seed treater for applying pesticides is recommended but not required.
5. Baggers, scales, bag storage and bulk storage should be adequate for maintaining accurate seed quality and quantity.
6. Forced air and vacuum cleaning equipment should be available for completely cleaning the equipment and the facility.
7. All equipment used must be designed to allow complete cleanout.
8. All dumps, holding bins, surge bins, elevator heads, elevating equipment, distributor spouting and elevator legs must be designed and installed for complete cleanout.

Final Testing

A sample of seed that's been conditioned must be submitted to the NCIA Lab to complete certification. All seed is tested with the procedures set by the most recent edition of "Rules for testing Seeds" from the Association of Official Seed Analysts. If seed passes its class' standards, it may be marketed as certified seed.

Seed in the process of being sorted and cleaned. *Photo courtesy of UNL ARD.*

* To view the complete guide, visit NCIA's website at http://www.unl.edu/ncia/Standards1.pdf

Field Preparations

Producers' livelihood comes from the land. However, a variety of factors can limit the productivity of a field: moisture availability, nutrient availability and erosion. As a result, producers must act as stewards of the land by preserving the quality of their fields. Several different farming practices allow producers to preserve both the integrity and the productivity of their land.

Fallow Fields

Although wheat is a dryland crop, it does need moisture to survive. In areas of western Nebraska, where precipitation levels are lower, producers must work to maximize effective production with the moisture they have. As a result, producers often leave fields **fallow** to increase soil moisture levels. A field becomes fallow when producers choose not to plant it the season following its harvest. The season when the field is empty is known as the fallow season. Essentially, fallow land allows producers to use two seasons of moisture on one season of crop.

Producers control weeds during a fallow season to prevent them from using moisture that will be needed by the wheat. The moisture from the fallow season will be used by wheat planted the following September. In areas with limited precipitation, such as the Panhandle, this practice is advantageous. It's less common in eastern Nebraska. Producers will often incorporate fallow fields into a rotation. Common fallow rotations include wheat - fallow - wheat - fallow, or wheat - summer crop - fallow - wheat.

A wheat field that's been harvested sits next to a field which remained fallow for the season. The currently fallow field will be planted in the fall and the harvested field will be left fallow. *Photo by Zoe Olson.*

Leaving land fallow also helps with disease management by breaking up disease cycles and disrupting insect cycles by removing the crop upon which the diseases or insects depend. If a field has disease pressure during a season, eliminating the wheat on which the disease or insects depend for survival for a season helps lessen the likelihood of reoccurance in the next crop planted in that field. Producers also work to control **volunteer** populations (wheat that grows from berries left in the field during harvest) to decrease the opportunity for residual disease or insect pressures, both in that field and in a neighboring field.

Tilling Operations

Erosion and **runoff** can seriously impact the productivity of producers' fields. Wheat pulls many of the nutrients it needs to survive from the soil. However, strong winds can blow away and erode nutrient-rich topsoils and excessive moisture can create runoff and wash the soil away. Various tilling operations used by wheat farmers, help prevent both.

Tilling is the process of preparing soil for planting. In a no-till wheat operation, producers will harvest the wheat and leave all straw and stubble in the fields. The plant material which is left behind is known as **residue**. The presence of the residue creates a hold on soil and prevents winds from blowing as much away, especially in sandy soils. Residue also increases the water holding capacity of soil, reducing runoff. Not disking the soil in preparation for planting means a decrease in fuel and labor inputs. However, no-till operations also have an increased use of herbicides to combat weeds.

In minimum-till operations, producers harvest the wheat but disk some of the straw before planting. A land finisher helps smooth the soil and make a firm seed bed for planting.

A producer disks his field in preparation for planting. This type of equipment in most frequently used in conventional-till operations. *NWB file photo.*

Soil Testing

Producers often conduct soil tests shortly before seeding to determine the nutrient status and its variability for each field. Knowing this lets producers adjust which fertilizers they use and the amounts they apply. Proper fertilizer application can reduce incurred costs for producers, increase yields and minimize the fertilizer's impact on the environment.

Most tests check for levels of elements like Nitrogen (N), Potassium (K), Phosphorus (P), Sulfur (S), Copper (Cu), Iron (Fe), Magnesium (Mg), Manganese (Mn), Sodium (Na) and Zinc (Zn). Soil pH and organic matter content are also tested.

Usually, a soil probe is used to collect a **soil core**. The often-used standard for testing is 10 to 15 random surface cores for nutrient analysis and six to eight subsoil cores for nitrogen analysis per 40 acres.*

Producers usually check surface soils (0" to 8") first. Surface samples help deterine the soil's pH, lime need, the amount of organic matter, P, K, S and Zn. Surface tests alone, however, are not sufficient for making nitrogen fertilizer recommendations.

Because nitrogen moves easily with water when it's in nitrate form, it can move into the subsoil. As a result, nitrogen recommendations are based on both surface samples and subsurface samples (8" to 36").

The length of time between soil tests on fields is usually chosen by the producer. Some producers test all fields annually while others test only the irrigated fields annually. Below is a chart which indicates the frequency certain elements should be tested for.

Soil Test	Testing Frequency
CEC/OM	15 years
pH	5 to 10 years
P, K, Zn	1-5 years
NO_3, SO_4	1 year

After the samples are collected, they're sent to an analysis lab for **correlation** and **calibration**. Correlation refers to the relationship between the amount of a nutrient extracted in a test and how much nutrient is required by plants. Understanding this relationship is beneficial because each crop has a varying response to different levels of nutrients. For example, winter wheat requires higher levels of P than corn and soybeans to reach maximum yields.

Calibration is the relationship between a specific test value and the yield response from adding fertilizer to the soil. As more fertilizer is added, the amount of yield increase per unit added will eventually decrease. Calibration helps producers determine the amount of fertilizer that maximizes output while minimizing potential overapplication. This not only protects the soil, it also prevents a waste of resources.

Producers may also conduct leaf tissue tests close to harvest. These tests reveal whether or not plants were short on certain nutrients. Producers can do little to help the crop at that point, the but data provides a guide for fertilizer adjustment on the following crop.

* Source: The University of Nebraska-Lincoln Extension, Institute of Agriculture and Natural Resources. *NebGuide* **www.ianrpubs.unl.edu/epublic/live/ec155/build/ec155-9.pdf**

Planting

Planting of winter wheat in Nebraska usually begins in September in the western part of the state and progresses east through October. Planting in the east occurs later as producers often plant wheat in fields where beans or other crops have just been harvested. Planting dates play a vital role in the health of wheat. Planting early allows for plant growth which can reduce wind erosion; but too much growth can reduce soil moisture. Later planting convserves moisture, but the decreased growth results in lower soil protection.

Preparation

Producers take great care in the preparation of equipment for planting. All vehicles and equipment are inspected for parts showing wear. Parts that require it are replaced or adjusted. Wiring, air tanks and lines are checked to make sure no rodent nesting occurred during the time equipment sat idle.

In addition, producers are organizing the logistics of planting. After choosing a class of wheat (HRW or HWW), producers must choose and purchase the varieties they wish to plant. Because the geography of Nebraska is so varied, producers in the East will often plant different varieties of wheat than producers in the West. Decisions are based on varieties that will produce well and contain characteristics that are advantageous for the area of production (height or disease resistance).

Field preparation differs from operation to operation depending on the amount of tillage a producer prefers. In minimum till and conventional till operations, producers will disk their fields to varying degrees.

Weed and disease pressures in the fields must be controlled prior to planting. Producers often kill weeds by spraying or tilling. Eliminating volunteer wheat on adjacent fallow fields helps control the potential spread of disease to the new crop.

A wheat producer in western Nebraska sprays wheat stubble in his field to prevent weeds from usuing all the moisture. *Photo by Zoe Olson*

Planting Technology

Use of technology increases the efficiency of planting. GPS guidance in tractors decreases overlapping in fields which reduces over-application of seed and fertilizer. This in turn reduces wear on equipment.

Producers use different drills depending on soil type and residue (are they running a no till or minimum till operation). However, **hoe drills** (also known as air seeders) and **disk drills** are most common. Technology within the drills helps increase efficiency and quality control.

Hoe drills use hoe openers (points that go into the ground and open the soil). A seed flows out the bottom of the opener, and a press wheel packs dirt back down onto the

September

Planting begins in the Panhandle region of Nebraska.

Planting progresses to the southwestern part of the state.

Planting

This producer is using an air seeder to plant in a no till field. The tank attached at the back allows him to fertilize at the same time. *NWB file photo*

seed. Hoe openers are beneficial for producers during a dry year since they can get the seed deeper in the soil. The mound of dirt from the soil disturbed by the hoe opener helps protect the seedling from wind and the elements. Hoe drills can be used for any type of production, but are popular on no till operations.

Disk drills are usually referred to as single or double (one or two blades). A slightly angled blade creates a slit in the soil. The seed is placed in that slit and a press wheel packs dirt back down onto it.

Meters and adjustable gates on tanks and cups will rotate and drop seeds depending upon the drill speed and application rate producers choose. This also helps prevent over application of seed and/or fertilizer.

When planting and fertilizing at the same time, openers can place seed in twin rows above and to the side of fertilizer, allowing the roots of two plants to proceed downward into one portion of fertilizer once the seed has germinated. This method of fertilization is called **banding** because the fertilizer is in a "band" below the seed. Planting and fertilizing at the same time also increases fuel efficiency be reducing the number of tractor passes across a field.

Adjustable down-pressure springs on openers allow more or less pressure to be applied depending on whether the ground is hard or soft. This helps producers place seed at more consistent depths across varying soil conditions.

Clean up

After planting is finished, producers clean the inside and outside of all machinery used. Seed and fertilizer are cleaned out and removed, drills are washed, all accessible parts are vacuumed, any oil or dirt is washed off and the machines are greased before storage. Equipment is usually stored in enclosed sheds.

Weather Challenges

Weather conditions pose one of the greatest challenges to wheat producers. Planting requires moisture, but too much moisture can delay planting, and wheat that is planted late may not mature enough before dormancy to withstand the winter.

However, too little moisture can also cause problems. Producers want to plant in moist soil because moisture is necessary for wheat seeds to germinate* and then emerge. A lack of moisture during and after planting may prevent the wheat from emerging and developing enough before dormancy, if it emerges at all.

Planting progresses into the south central part of the state and wraps up in the Panhandle.

October

Planting begins in the east, wraps up in southwest and south central Nebraska, and is complete in the Panhandle.

* To learn more about this process refer to the Growing Season section (p. 14)

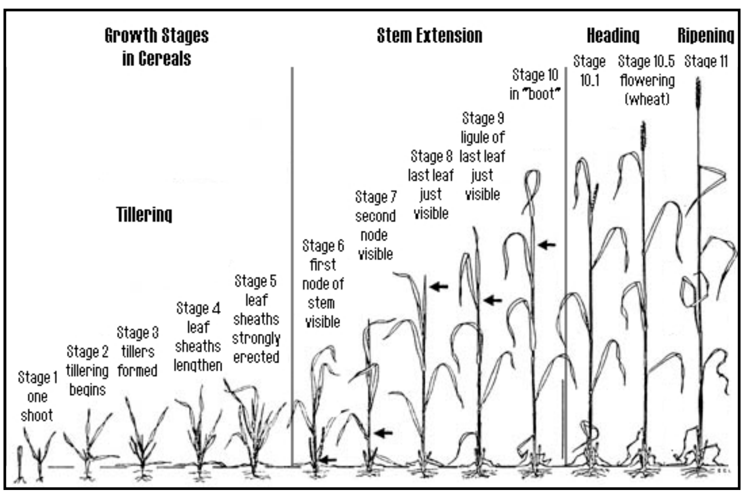
Growing Season

Because disease and insect pressures appear at different times, and because fertilizers, pesticides and other chemicals should be applied at certain points during the wheat's life, producers pay close attention to the various growth stages of wheat.

Growth Stages

Wheat growth can be separated into vegetative and reproductive stages. The Feeke's system, pictured below, is most commonly used for determining the stage of growth.

Once the seed has been planted, it must germinate. After germinating, the wheat plant will emerge from the topsoil. The plants will begin to form tillers. The amount of tillers present determines the stage of growth. Tillering may or



may not be completed before winter and dormancy begin. As soil temperatures drop, plants begin to enter dormancy and the crowns of the plants begin to harden. Hardened crowns can withstand temperatures as low as -9^{o}F. However, having some plant growth and a layer of snow can create a buffer layer of insulation to protect the crown from the severe cold and winds of Nebraska's winter.

Once a plant forms all its tillers, it will begin **elongation** of its internodes. However, this stage will not occur before **vernalization** (completion of dormancy) in the spring.

Boot stage occurs when the wheat head begins to form inside the sheath of the flag leaf. When the head fully emerges from the stem (**spike emergence**), vegetative growth is finished and reproductive growth begins.

The **flowering** stage of reproductive growth occurs when the anthers emerge. Once all anthers have emerged, **ripening** starts. This is the stage where wheat takes on its characteristic golden color. Wheat can be harvested as soon as ripening is finished.

Field Scouting

Producers scout fields for weed, insect and foliar diseases in the spring, following the end of dormancy. If pressure

Producers Larry and Kevin Flohr examine one of their wheat fields for disease pressure in the early spring. *Photo by Zoe Olson*

November

Wheat continues to emerge across the state.

December

Wheat is dormant. Producers want snow for cover and moisture.

January

is found, producers spray for weeds. Usually weed control occurs in April. If necessary, fungicide application occurs prior to wheat heading. Producers continue to scout and watch for disease and insect pressures throughout the growing season.

Fertilization

Producers tend to apply fertilizer in one of three ways: **banding** (for more information refer to the planting section of this report), **broadcasting** (also known as **top dressing**) or **fertigation**.

Broadcasting or top dressing usually occurs shortly after wheat breaks dormancy. Producers apply Nitrogen fertilizer over the top of the entire crop. Some producers prefer other methods of application over broadcasting because of the concerns that the fertilizer may get lost or caught up on standing residue.

Fertigation is the method producers frequently use on irrigated fields. Nitrogen fertilizer is injected into the water of an irrigation system. The system then distributes the water and fertilizer over the field. Application with this method may occur as many as two or three times prior to heading in order to improve wheat quality and yields.

Pesticide Application

Pesticide in this instance is defined as any substance or mixture of substances intended to prevent, destroy, repel or mitigate any pest; and any substance or mixture of substances intended for use as a **plant regulator**, **defoliant** or **desicant**. Pesticides may include **herbicides**, **insecticides** and **fungicides**.

Pesticides, when not applied properly, can have negative effects on water sources and the environment. However, when applied properly, pesticides provide large production and labor benefits to farmers.

A 2009 study conducted by CropLife Foundation, found that losses in Nebraska due to insects on wheat not treated with insecticides could total as much as 40 percent. This translates as an annual production loss of $9.8 million for producers.

Herbicide removal of weeds means farmers do not have to till fields. This reduces labor inputs and allows fewer farmers to manage more acres. Eliminating the need for tilling weeds allows producers to incorporate no till and mimimum till systems into their operations. Both systems help the environment by minimizing soil erosion and increasing the water holding capacity of soils.

In addition, CropLife Foundation estimated the use of herbicides increased crop production by 20 percent in 2005. Greater yields per acre mean fewer acres need to be used to produce the same amount of wheat.

Licensing and Certification for Pesticide Application

In accordance with regulations outlined by the Nebraska Department of Agriclture (NDA), producers applying pesticides are licensed.

Producers begin the licensing process by acquiring certification as an applicator. Certified producers must demonstrate their knowledge and competence in regards to purchasing, transporting, storing, using, disposing of or supervising the use of restricted-use pesticides in various

Wheat maintains dormancy.

February

Wheat maintains dormancy.

March

Wheat breaks dormancy and continues growth.

situations. Producers are evaluated wtih exams and/or training sessions. All exams are based on the standards outlined in the U.S. Environmental Protection Agency's Code of Federal Regulations.

After receiving their certification, producers can apply to NDA for their pestice applicator license. Licenses last three years and are subject to renewal if the applicator attends a NDA approved training session. Usually these sessions are offered by UNL Extension Service. Producers applying for a recertification can also complete a written examination. Once recertified, the producer may apply for a license renewal.

Qualifications of Certified Applicators*

- Has a basic understanding of pest biology
- Is able to recognize and accurately diagnose pest infestations
- Is able to recommend and use the proper chemical(s) for control of pest infestations
- Possesses basic arithmetic skills appropriate to pesticide use and equipment calibration
- Has a working knowledge of the use and maintenance of all necessary application equipment
- Is familiar with pesticide toxicities, types of exposure, harmful effects and signs and symptoms of poisoning
- Is able to assess the treatment site to minimize or prevent the potential adverse effects of the pesticides on the surrounding environment
- Is aware of and able to comply with federal, state and local laws and regulations regarding pesticide use, including record keeping requirements

Pesticide Regulations

Because of the chance for pesticides to end up in water sources, various environmental regulations for pesticides, including a maxiumum contaminant level, have been set by the U.S. Environmental Protection Agency (EPA) and various state agencies.

In addition, the EPA is required to evaluate all pesticides before they can be marketed or used in the U.S. These tests can include studying the ingredients, where the pesticide will be used, on which crops, the amount and frequency of use needed, storage and disposal requirements and potential adverse effects on humans, animals and other plant life. If a pesticide meets the required health and environmental standards, a license is granted allowing the pesticide to be sold.

Pesticides may only be used in direct accordance with the directions listed on the label at the time of sale. Any deviation is illegal.**

April

Wheat elongates, joints and may enter the boot stage.

May

Wheat finishes boot stage and begins flowering.

* Source: The Nebraska Department of Agriculture Bureau of Plant Industry's *Pesticide Applicator Certification and Licensing.* **www.agr.ne.gov/division/bpi/pes/cert.htm**

** Source: Heartland Regional Water Coordination Initiative and USDA's *Pesticie Management for Water Quality Protection in the Midwest.*

Harvest

Although eastern Nebraska plants last, the area is the first part of the state to begin harvesting. Harvest usually starts in June and runs through July, progressing west across the state.

Weather's Effects

Although the golden fields of ripe wheat ready for harvest have been depicted as things of great beauty and peace in multiple photos and songs, harvest is a stressful time for producers. The timing of harvest depends entirely on the weather. To prevent spoilage and insect growth, wheat needs to be at specific moisture levels when stored. If the wheat has too much moisture (usually anything higher than 14 percent) a producer will wait to harvest. Sometimes this can mean waiting for the sun to rise and dry the dew from fields. Other times it can mean waiting several days for fields to hit ideal moisture levels after a heavy rain. This means producers, to ensure quality wheat with proper moisture levels, will increase the risk and exposure of their fields to potential damage or loss.

Ripe wheat is more susceptible to elemental damage. Summer thunderstorms bring not only rain, but excessive winds that can make wheat lie down in fields. Wheat that's been blown and flattened in fields is harder to harvest. Producers must slow combines down in order to let headers pick up the wheat in those areas of fields. This means other fields remain exposed to elements and more fuel and labor costs are accumulated. In addition, full yield potential isn't always reached in weather-damaged fields and the likelihood of volunteer wheat increases.

Hail can be devastating to wheat producers. Producers whose fields are hit with hail can see anywhere from minimal to complete yield loss. Hail damage can also knock wheat seeds loose into the field and, as a result, increase odds of volunteer wheat. This means producers again, incur more costs to control the volunteer wheat.

In order to get harvest completed on time and ahead of the elements, producers and **custom combine teams** will often work until sunset or later. Custom combine teams are groups of people who travel across the country with harvest equipment for hire. Often, hiring custom combiners to help with harvest can be more economically efficient for producers than owning their own harvest equipment. Some producers run their own harvest equipment and hire custom combiners to speed up harvest rates.

Some wheat in this field has been flattened by winds in excess of 50 mph. Producers have to slow down to harvest these areas, which costs them more time, more fuel and lower yields. *Photo by Zoe Olson*

Preparation

Producers take every precaution to prevent contamination or problems that would damage wheat quality during the harvest process.

June

Wheat finishes flowering and starts ripening.

Harvest begins in eastern Nebraska.

July

Harvest

Before the combines enter the field, they are inspected for wear and/or needed adjustments of belts, chains and bearings. The machines are lubricated in accordance with their respective manuals. In addition, all trucks and on-farm grain bins are cleaned and bins are sprayed to prevent pests.

Using Proper Equipment

Producers begin the harvest process by selecting the right equipment for their type of production. Like in planting, GPS helps prevent extra travel by the combines as they harvest.

Producers running minimum till or conventional till operations often use conventional platform headers on their combines. With this setup, the header reel pulls the wheat to the sickle so the sickle can more easily cut the stems. The entire piece of the wheat plant cut is pulled into the combine and thrashed as it passes through. The **chaff** and **straw** are spread on the ground as evenly as possible via the back of the combine. This helps minimize residue hindrance in planting.

This combine has a stripper header and is part of a custom team's combine fleet. *Photo by Zoe Olson*

Stripper headers are most often used by producers who use no till farming methods. Stripper headers operate so only the wheat head is taken from the plant. The rotor below a stripper header's shield rotates in the opposite direction of the combine's tires, creating an upward pull on the plant. Fingers on the rotor go between the plants and strip the head off the stem. The remainder of the plant is left standing as residue.

After the grain is in the combine, the wheat kernels are moved to a grain bin on the back of the combine. From there the wheat is moved to a grain cart and then to a grain truck or an on-farm storage bin. Occasionally producers will dump grain directly from the combine's bin into the grain truck. The grain not stored on-farm is taken to the local grain elevator.

Clean up

Following harvest, combines are cleaned again. All dust and debris is removed, and grains left behind are removed from the combine bin. Special attention is given to grain removal as grain that's left in the machine can cause rodent problems. Equipment is then stored in an enclosed shed.

Also, if a producer raises both HRW and HWW, the combine, grain carts and grain trucks are cleaned between harvesting of each type to prevent contamination (mixing HRW with HWW).

Harvest is wrapping up in the east and begins in south central Nebraska.	Harvest progresses west into the Panhandle and is finished in the east.	Harvest is finished in most of the state and wrapping up in northwestern Nebraska.

Testing

Nebraska wheat producers and elevators work to ensure they provide the best product possible. As a result, wheat is tested for many different characteristics at several levels before being sold and/or used.

Wheat testing begins at the farm level. All producers test moisture before harvest to ensure levels aren't so high that spoilage will occur. Often a hand-held moisture tester is used to check the wheat. Producers, especially those storing wheat on their farm, will also check the test weight of their wheat.

Further tests (moisture, test weight, protein) are conducted by most local elevators directly before purchasing the wheat from producers. As the wheat progresses to export elevators, further tests are conducted. Different characteristics can affect the quality and value of wheat. The following is a list of various characteristics wheat may be tested for.

Rail cars from a shuttle train bound for an export elevator are rolled under the garner and are filled with wheat at this county elevator in northwestern Nebraska. *Photo by Zoe Olson*

- **Moisture** content is the percentage of moisture by weight of a sample and is an important indicator of profitability in milling. Flour millers add water to adjust wheat moisture to a standard level before milling. Lower wheat moisture allows more water to be added, increasing the weight of grain to be milled at virtually no cost. Moisture content is also an indicator of grain storability as wheat and flour with low moisture are more stable during storage. Because moisture can be readily added to or physically removed from a sample, other analysis results are often mathematically converted to a standard moisture basis, such as 14 percent, 12 percent or dry matter. This allows for a meaningful comparison of results.
- **Protein** content is the percentage protein by weight in a sample. Protein can be quickly and easily measured and therefore is an important factor in determining the value of wheat since it relates to many processing properties (water absorption and gluten strength). Low protein levels are desirable for products like snacks or cakes. High protein levels are desired for products like pan breads, buns and frozen yeast-raised products.
- **Dockage** is the percentage by weight of any material easily removed from a wheat sample using the Carter Dockage Tester. Dockage, because it can be easily removed, should not have any effect on milling quality, but may have other economic effects for buyers. Grade factors are determined only after dockage is removed.
- **1000 Kernel Weight** (TKW) is the weight in grams of one thousand kernels of wheat. It's often used by millers as an indication of grain size and expected milling yield because higher TKW is usually associated with greater flour extraction.
- **Kernel Size** is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.
- **Test Weight** is a measure of the density of the sample. It may be an indicator of milling yield and the general condition of the sample as problems that occur during

the growing season or harvest (too much rain or too little rain) may reduce test weight.

Federal Grain Inspection Service

The Federal Grain Inspection Service (FGIS) of the USDA Grain Inspection, Packers and Stockyards Administration (GIPSA) sets quality grade standards for grain. Wheat grades are important because they reflect the physical quality and condition of a sample and thus may indicate the general suitability of a sample for milling. Grades are applied when local elevators go to sell their grain for both domestic and international consumption. The table below

OFFICIAL U.S. GRADES AND GRADE REQUIREMENTS

Grading Factors	Grades				
	No. 1	No. 2	No. 3	No. 4	No. 5
HARD RED WINTER - MINIMUM TEST WEIGHTS					
LB/BU	60.0	58.0	56.0	54.0	51.0
MAXIMUM PERCENT LIMITS OF:					
DEFECTS					
Damaged Kernels					
Heat (part of total)	0.2	0.2	0.5	1.0	3.0
Total	2.0	4.0	7.0	10.0	15.0
Foreign Material	0.4	0.7	1.3	3.0	5.0
Shrunken and Broken Kernels	3.0	5.0	8.0	12.0	20.0
Total*	3.0	5.0	8.0	12.0	20.0
WHEAT OF OTHER CLASSES**					
Contrasting Classes	1.0	2.0	3.0	10.0	10.0
Total***	3.0	5.0	10.0	10.0	10.0
Stones	0.1	0.1	0.1	0.1	0.1
MAXIMUM COUNT LIMITS OF:					
OTHER MATERIAL (1,000 gram sample):					
Animal Filth	1	1	1	1	1
Castor Beans	1	1	1	1	1
Crotalaria Seeds	2	2	2	2	2
Glass	0	0	0	0	0
Stones	3	3	3	3	3
Unknown Foreign Substance	3	3	3	3	3
Total****	4	4	4	4	4
INSECT-DAMAGED KERNELS (in 100 grams)	31	31	31	31	31

illustrates the standards for U.S. grain grades and grade requirements as set forth by FGIS.
Below are several characteristics analyzed in grade determination. Each characteristic is measured on a percentage and assigned an amount which is acceptable. Increased levels of each will result in a decrease in grade quality.*

- **Damaged Kernels** are the kernels which may be undesirable for milling because of disease, insect activity, frost or sprout damage.
- **Foreign Material** is any material other than wheat that remains after dockage is removed. Because foreign material may not be removed by normal cleaning equipment, it may have an adverse effect on milling quality.
- **Shrunken and Broken Kernels** are those kernels which were either insufficiently filled during the growing season and as a result have a shrunken and shriveled appearance or have been broken in handling. Such kernels may reduce milling yield.
- **Total Defects** is the sum of damaged kernels, foreign material and shrunken and broken kernels.

While some companies (usually food companies like ConAgra) offer premiums to select producers for producing specific varieties of wheat, most producers market their wheat at the local elevator.

LOCAL ELEVATOR TESTING AND OPERATIONS

Producers deliver their grain to local elevators by truck. Upon arrival, a pneumatic probe collects a representative sample of the grain which is delivered to the elevator's lab. In the lab, test weight, protein, moisture and foreign material are all evaluted. The tests help elevators determine the wheat's quality and grade, both of which will affect storage and shipping.

Test weight is calculated by weighing one quart of wheat. Special scales in the lab automatically convert the sample weight into pounds per bushel.

Foreign material is checked for by running a sample of dirty wheat (uncleaned) through a machine that cleans it. The foreign material removed is weighed and a measurement is given as a percentage of the original sample weight.

Most elevators will accept up to 1 percent without a direct penalty. However, farmers still lose for having dockage because the amount of dockage is deducted from the shipment's total weight.

Once these tests are completed, the wheat is inspected to make sure there are no insect damaged kernels, rye or wheat of other classes (WOCL), bugs, chemical treatments and sprout damaged, germ damaged or heat damaged kernels.

Once a truck is probed, a gross weight is collected on an inbound scale. A ticket produced after weighing tells the driver which pit to drive to and informs the pit operator which bin to dump the wheat in. Once the truck is empty, its weighed on an outbound scale ad a ticket is produces detailing the number of bushels dumped and the test results from the lab.

A probe at a local elevator in central Nebraska collects samples from this grain truck to run quality tests on. *Photo by Caroline Brauer*

* For more infomration on how FGIS conducts these tests, view the *Overview of U.S. Wheat Inspection* at http://www.uswheat.org/uswPublic2009.nsf/3f1e3b91ed7dc84a852575e400579f77/9cede08317adbd7c852575e5004fc6a7/$FILE/ATTX8SLN.pdf/fgis2007.pdf

Testing & Shipping

Because wheat is sorted into bins by protein levels, an employee is usually stationed at each pit in an elevator to ensure trucks are at the correct pit and wheat is being dumped into the correct bin.

All lower quality wheat (high number of damaged kernels, high moisture, or rye and WOCL) is marked differently and kept in separate bins regardless of protein level. High moisture wheat is stored in bins with aeration fans that move air through the bin to lower the moisture or keep it from worsening.

Bins are regularly checked to ensure stored grain maintains its integrity. The grain is monitored for the presence of bugs and mold. Temperature and moisture levels are also monitored. Maintaining specific moisture and temperature levels is important in preventing bugs from inhabiting the grain and keeping hot spots from developing. Hot spots can cuase fires or heat damaged kernels.

Wheat that has been stored for an extended period of time may be moved from one bin to another. This aerates the grain to prevent it from spoiling while allowing quality throughout the bin to be evaluated. However, other than the exception listed above, most elevatort try to minimize the movement of grain between bins as the movment can compromise the wheat's integrity or cause more broken kernels.

Wheat usually leaves local elevators in trains bound for export elevators. Shuttle trains (110 cars long) are used most frequently. Loading times vary between elevators depending on the facilities each has, but it can take upward of 10 hours to fully load a train.

Wheat is often moved out of several different bins and blended together to create ideal protein levels. This occurs as the train is being loaded. The wheat is moved out of the different bins and into a common leg which lifts the grain into the garner located above the train cars. The grain mixes as it drops out of the garner and into the train cars.

EXPORT ELEVATOR TESTING AND OPERATIONS

Wheat with high levels of dockage hurts buyers in three different areas.

- They've paid for extra weight they won't use.
- They must pay to clean the wheat.
- They must pay to dispose of the removed materials

Therefore, it's important for elevators to have as clean of wheat as possible.

The U.S. Grain Standards Act (1916) mandates official inspections on most grain for export and provides services for domestically purchased grains on request. Auditors and supervisors are present at all inspection locations to ensure accuracy and prevent bias of all personnel. State and private labs may conduct tests on wheat for domestic trade, but federal and state labs usually conduct export inspections. To receive an official grade, all equipement, inspectors and procedures must be approved for accuracy, and the inspection must be conducted as outlined in the U.S. Grain Standards Act.

Before export vessels are loaded, the holds are inspected for defects including, rust, insect infestation, oil sludge and water. Vessels must be clean and dry before loading can start.

FGIS divides wheat being loaded onto export vessels into sublots based on the particular elevator's hourly loading rate. The sublots are checked for uniform quality. Each sublot has to meet the grade and characteristics asked for by the purchaser. If a sublot doesn't meet the requirements, it's certified separately or not included in the shipment. Certificates issued by FGIS represent the average of the sublots' examination results.

Once the wheat is inspected and a grade has been given, a white certificate with the collected data is issued to represent the inspected lot.

Beyond the Field

Agriculture is a field of constant change. Producers must not only remain up-to-date on the current issues and legislation facing the industry, they must also be aware of new technology used in production.

Record Keeping

Part of running an organized operation involves keeping extensive and accurate records for all production practices. Producers use their records to compare data (yields, soil nutrient levels, etc.) between years in order to ensure progress and the quality of the crop is maintained or improved with subsequent harvests.

Nearly all producers track what is grown on which ground and when. They record which fields are fallow and which have rotation crops like beans or sugar beets. They also track which class of wheat (HRW or HWW) is in each field and the variety of class that's been sown.

Producers also document harvest data: yield, protein, moisture, dockage. Technology helps in this area as most combines are equipped with computers to track variety and yield data for each field. Producers can simply transfer the information to records or spreadsheets on office computers. This enables them to see what worked and what they need to improve.

Records of which chemicals (herbicides, fertilizers, pesticides) are applied to the crop and when are often kept in spray logs. Data on soil testing is also kept. Both records help producers watch for patterns or similarities between fields.

Other records may include planting and harvest dates. Producers with on-farm storage keep records of which varieties of wheat, in what quanities and what conditions are stored where an when in all their bins. All of these records are kept in addition to financial records like basis, wheat prices and operational input costs.

Educational Opportunities

Nebraska's producers remain at the forefront of their profession by continually learning more about wheat and farming technology. They actively participate in clinics offered by UNL Extension and workshops hosted by the Nebraska Wheat Growers Association. These workshops and clinics focus on issues ranging from railroad basis rates to crop pests to advances in certified seed.

In addition, NWB works to ensure producers have the opportunity to understand the export and food processing aspects of wheat and wheat food production. Each year NWB hosts 15 producers and elevator operators on a tour of the Wheat Marketing Center in Portland, Oregon.

There the producers are exposed to wheat quality testing methods, food and baking tests as well as fundamentals of the export market and port facilities.

Members of the 2008 NWB sponsored trip to Portland pose in front of a large export cargo ship. *File photo.*

Glossary

Banding: The style of fertilization where the fertilizer is placed in the soil below the seeds in strips called bands.
Boot stage: The stage of wheat growth when the head begins to form in the flag leaf.
Broadcasting: The style of fertilization where fertilizer is applied over the top of the field area. See top dressing.
Chaff: The husklike portion of the plant surrounding wheat berries which is separated from the head and berries by combines during harvest.
Chlorosis: Yellowing of plant tissues.
Crown: The portion of the plant at the surface soil level where the plant stem meets the roots.
Cultivar: A variety of plant developed through selective breeding methods.
Custom Combine: Person or team of people who work for hire, providing the equipment and labor to harvest crops.
Defoliant: A substance which causes leaves to fall off.
Desicant: A substance which causes increased dryness.
Disk Drills: This type of drill has blades called disks which cut slits into the soil in which the seeds are placed.
Elongation: Process of growth during vegetative stage when plant lengthens portions between nodes.
Endemic: Restricted or native to a particular location.
Erosion: The gradual wearing away of soils, usually by wind or water.
Fallow: The practice of not planting crops on a field the season following harvest.
Fertigation: The style of fertilization where Nitrogen is applied to the field via water in an irrigation system.
Flowering: Stage of growth when anthers emerge on wheat heads.
Hoe drills: A type of drill, common on no-till operations, which uses air to depost seeds deeper into the soil. Also called air-seeders.
Jointing: Stage of growth when the first node becomes visible above the ground.
Necrosis: Death of tissues.v
Protein: An important component of all living cells, it's necessary for the proper functioning of an organism, and is essential in the diet of animals for the growth and repair of tissue.
Ripening: The process near the end of reproductive growth where plants start to turn from green to gold.
Rogue: The process of removing volunteer plants of the crop variety planted during the previous season from the field.
Runoff: The flow of water away from a particular location.
Soil core: Collection of soil pulled from ground with special equipement to test for nutrient levels.
Spike emergence: The end of vegetative growth when the wheat head fully emerges from the flag leaf.
Straw: The stems of wheat plants deposited in the field by combines or colleted into bales after harvest.
Top Dressing: The style of fertilization where fertilizer is applied over the top of the field area. See broadcasting.
Vernalization: The process of submitting wheat to cool weather for an extended period of time between tillering and jointing. It's necessary for winter wheats.
Volunteer: The unplanned and undesired growth of plants from seeds of the previous season's crops. Often the seed is left behind during harvest or knocked to the ground by elemental damage like hail.

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