



WHITE WHEAT

An Alternative Crop for Oklahoma?

Production Technology - Crops



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This publication gives an introduction of hard white wheat as a potential specialty crop for the state of Oklahoma. The goals are to increase awareness of white wheat by highlighting its strengths and weaknesses and to indicate some important production practices required for white wheat to be successful in Oklahoma.

Topics

What is hard white wheat?

Market potential of hard white wheat

Potential problems for hard white wheat

Worldwide production areas of white wheat

Production practices of hard white wheat

Performance of hard white wheat

Future of hard white wheat

Key questions and responses

Conclusions

U.S. Wheat Growing Regions

To increase profits, Oklahoma farmers are evaluating alternative crops. Producing hard white wheat

in an identity preserved system is one alternative. An identity preserved system is one where the identity of a product can be maintained from planting seed to finished product. An example might be buying and planting certified Intrada seed. The wheat is harvested and kept separate from any other wheat. The wheat is delivered to a location where it is either kept isolated or co-mingled only with other Intrada, or co-mingled with other specified white wheat varieties, and finally made into flour.

WHAT IS HARD WHITE WHEAT?

Hard white wheat is similar in many ways to hard red winter wheat. The plants are similar and both have hard grain endosperm for making bread. However, the color of the seed coat (bran) is different. Bran color is determined by three major genes that do not affect other plant traits. Many modern varieties of hard red winter wheat have only one or two of these genes for red bran. White wheat, in contrast, has no major genes for red bran color and therefore is white.

MARKET POTENTIAL OF HARD WHITE WHEAT

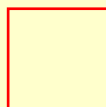
Advantages of hard white wheat are not fully known. In some international markets, millers, bakers, and consumers prefer white wheat whenever they have a choice. With rising publicity of this preference, interest has increased in the domestic and/or export market potential for hard white wheat. Marketability is very important to the producer.

Major food uses for white wheat include tortillas, pita, regular and whole wheat breads, buns, and Asian noodles. Currently, around 50 percent of the wheat flour in Asia is being converted into noodles. Fresh noodles made from hard white wheat are lighter in color, a characteristic preferred by Asian consumers. Hard white wheat is also a good choice for the Middle Eastern bulgur dish and for couscous, a staple of North Africa that is growing in popularity in the U.S. Furthermore, hard white wheat is the most desirable option for pasta manufacturers who use farina from hard wheat instead of semolina from durum wheat.

The food industry receives several benefits from white wheat that in turn are expected to increase demand:

- White bran imparts a less bitter taste than red bran. Also white bran is less obvious than red bran in flour and food products. Therefore, hard white wheat is preferred over hard red wheat in countries where a high percentage of the wheat bran is included in the flour.
- White wheat can be milled at a slightly higher extraction rate, yielding more flour than red wheat, making each bushel of white wheat more valuable. Millers can extract 1 to 2 percent more flour without darkening the flour color. It has been estimated that this greater extraction rate could be worth an additional five to seven cents per bushel. However, this additional extraction rate is frequently not obtained because mills are milling to a certain ash content regardless of whether they are milling red or white wheat.
- Whole hard white wheat flour or hard white bran can be used instead of non-wheat materials to increase fiber content of many existing products without altering color or flavor.

- Researchers have found that bread dough requires less sugar when it is made with white wheat flour instead of red wheat flour.
- Bran from white wheat is a co-product rather than a by-product, meaning it may have value as human food rather than primarily as animal feed.



POTENTIAL PROBLEMS FOR HARD WHITE WHEAT

Disruption of wheat movement through grain handling and marketing channels is a primary concern of introducing white wheat into Oklahoma. Any producer considering the production of white wheat may want to have a contract for grain delivery before planting white wheat. Currently, contracts are offering a premium, but producers need to read the contract carefully. There may be a very small premium for white wheat and the remainder of the premium offered is for meeting certain specifications on dockage, test weight, and/or protein content. If a contract specifies minimum quality for delivery, what does it say about disposition of wheat not meeting the minimum standard? Contracts may also designate the variety to be grown or seed source, or verification of certified seed being planted.

Quantity of white wheat produced in an area is another issue. An elevator operator or miller is unlikely to accommodate a new class of wheat unless a sizable quantity is available. A final factor is whether there is sufficient quantity for efficient transportation from elevators to mills or export market points.

Mixtures of white and red wheat can interfere with wheat marketing. In many cases these mixtures can result in significant discounts. Mixtures can occur anywhere in the chain from seed producer to consumer, but two primary concerns are mixtures in the field and in equipment. To keep from having mixed wheat, white wheat should not be planted in a field where red wheat was grown the previous year. Drills, trucks, combines, and bins should be thoroughly cleaned before using for white wheat.

Elevators must also segregate white wheat from red wheat in handling and storage, because mixed wheat sells at a discount. Therefore, an identity preserved system is probable as white wheat is introduced in an area.

Mixing hard red winter wheat and hard white wheat may cause the grade to be lowered. The official grading standards define hard white wheat as a contrasting class from hard red winter wheat. In Table 1, we can see that just 2% red wheat in a load of white wheat would reduce the grade to U.S. No. 2 and 3% makes it U.S. No. 3. Therefore, 3% red wheat in a load of hard white wheat could cause it to be rejected if the contract called for U.S. No. 2 hard white wheat. This means that if volunteer wheat results in 3 out of every 100 heads in the field being red wheat, the truck load would be graded U.S. No. 3 even if all other grading factors were okay for U. S. No. 1.

Table 1. Mixed wheat effect on grade.

Grade	Contrasting classes (%)
U.S. No. 1	1
U.S. No. 2	2
U.S. No. 3	3
U.S. No. 4	4
U.S. No. 5	5
Sample	>10
Hard white wheat and hard red winter wheat are considered contrasting classes.	

Preharvest sprouting of current hard white wheat varieties may be a higher probability in certain parts of Oklahoma and Kansas than hard red wheat varieties. After maturity, if rainfall, high humidity, and lower-than-normal temperatures delay harvest, the white wheat varieties sprout in the head more readily than most red wheat varieties. Preharvest sprouting indicates increased enzyme activity and starch degradation in the grain, destroying the bread-making ability of wheat. Therefore, wheat containing sprout damage may be discounted or classified sample grade (Table 2). Such wheat is generally sold for livestock feed at much lower prices than US No. 2 Hard Red Winter Wheat or Hard White Wheat.

Table 2. Sprout damage effect on grade.	
Grade	Maximum Damaged kernels (%)
U.S. No. 1	2
U.S. No. 2	4
U.S. No. 3	7
U.S. No. 4	10
U.S. No. 5	15
Sample	>15
Sprout damage is included in damaged kernels. When sprout damage is widespread, an additional discount for sprout damage may be applied in addition to lowering the grade.	

When introducing a new crop, it is very important to grow it in areas where it has the highest probability of success. In Oklahoma, preharvest sprouting is least likely in the panhandle and Northwestern Oklahoma because environmental conditions are more arid during harvest than in other parts of the state. The map on page 10 indicates the area that has the highest probability of being able to grow white wheat without sprout damage. Overcoming preharvest sprouting susceptibility is a major goal of wheat breeding programs in Oklahoma and Kansas and hopefully it can be reduced in wheat varieties released in the future.



WORLDWIDE PRODUCTION AREAS OF WHITE WHEAT

Australia is currently the major producer and supplier of hard white spring wheat. China produces a significant amount of hard white winter wheat. In the U. S., California, Montana, and Kansas are the major producers of hard white wheat. Several other states including Washington, Montana, New York, and Oregon produce soft white wheat (Figure 1).

Currently, the U.S. wheat ports are:

St. Lawrence and Lakes for durum, hard red spring, soft red winter, and soft white.

Atlantic for soft red winter.

Pacific for both hard and soft white wheat , hard red spring, hard red winter, durum.

Gulf for hard red winter, soft red winter, durum, and hard red spring.

Most wheat exported from Oklahoma moves through the Gulf. Therefore, if the Great Plains area were to produce white wheat, the Gulf port would have to accommodate an additional class of wheat.

PRODUCTION PRACTICES OF HARD WHITE WHEAT

Oklahoma producers interested in growing hard white wheat must avoid mixing hard white wheat with hard red wheat. Volunteer red wheat, wheat germinating from seed left from last year's planting or harvest, must be eliminated when hard white wheat is planted after hard red wheat or vice versa. This is best accomplished by not growing wheat in a particular field the year before switching from red to white wheat. Drills, combines, hauling equipment, and storage areas must be cleaned extremely carefully. If seed is kept for planting the next year's crop, then one class should be harvested from areas no closer than 20 feet away from fields of any other class. All production practices (seeding date, seeding rate, fertilization, and harvesting) are alike for hard white and hard red winter wheat. The same equipment is used for both crops.

Grain of hard white wheat should be harvested promptly after it ripens to avoid exposure to wet, humid weather. White wheat should be harvested first, if both hard white wheat and hard red wheat are being grown and ripen simultaneously. Grain that has sprouted extensively should not be used for seed.

PERFORMANCE OF HARD WHITE WHEAT

Currently several hard white wheat varieties are being grown on small acreage in the southern Great Plains. Arlin, Betty, Heyne, Intrada, Oro Blanco, and Trego have been or are currently being tested in the OSU wheat variety trials. Tables 2-4 include data from 1998 to 2000 forage and grain harvest. From these data we conclude that there are hard white wheat varieties comparable in grain yield, test weight, and fall forage yield to the best hard red winter varieties currently grown in Oklahoma.

Table 2. Fall forage yield in lb/a of several hard white wheat (HDWT) varieties and widely grown hard red winter wheat varieties (HRWW).

Class	Entry	1998		1999		
		Chickasha	Perkins	Chickasha	Kingfisher	Perkins
HDWT	Intrada	3070	2590	2380	2430	2180
HDWT	Trego	-	-	2560	2490	2690
HDWT	Betty	2940	2260	-	-	-
HDWT	Heyne	2840	2220	2250	2370	2430
HDWT	Oro Blanco	3520	2310	2350	2350	2150
HRWW	Custer	3310	2410	2430	2650	2530
HRWW	Jagger	2880	2470	2160	2440	1990
HRWW	2174	3060	2650	2740	2660	2380
HRWW	2137	3340	1850	2000	2390	2220
Trial mean		3100	2260	2440	2450	2310
LSD (0.05)		N.S.	N.S.	550	420	N.S.

All locations planted in Sept. at 120 lb/a except Kingfisher which was planted Oct. 1 at 60 lb/a.
Forage produced by mid-December as measured by clipping to the soil surface.

Table 3. Test weight in lb/bu of several hard white wheat varieties and widely grown hard red winter wheat varieties

Entry	1998-1999				1999-2000							
	Alva	Boise City	Cherokee	Goodwell Dryland	Alva	Balko	Boise City	Cherokee	Elk City	Gage	Goodwell Dryland	Irr.
Intrada	60.4	60.0	59.6	62.1	59.8	56.9	61.2	58.8	58.7	58.3	59.9	60.3
Trego	-	-	-	-	60.0	56.9	61.8	59.4	58.9	58.2	60.1	60.8
Betty	59.1	57.9	58.0	59.1	-	-	-	-	-	-	-	-
Heyne	58.8	55.7	56.5	59.8	56.9	51.9	60.0	56.1	57.4	57.0	58.0	57.9
Oro Blanco	58.6	54.5	56.2	60.9	56.5	56.2	58.9	57.2	57.7	56.5	59.0	59.2
Custer	59.9	58.0	58.2	60.4	58.0	55.7	61.4	57.0	57.2	57.5	59.3	59.7
Jagger	57.4	54.0	56.5	59.6	56.6	55.8	59.5	56.8	56.8	55.9	56.8	57.4
2174	60.0	58.0	58.7	60.8	57.7	54.4	60.4	58.2	58.1	57.7	58.4	59.0
2137	58.5	55.0	57.3	-	56.3	53.2	58.0	57.4	56.7	55.3	57.3	58.0
TAM 107	-	56.9	-	59.1	-	54.3	57.2	-	-	54.9	57.4	58.7
Trial mean	58.5	56.5	57.3	60.1	57.6	53.9	59.7	57.4	57.6	56.8	58.3	58.9

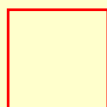
LSD (0.05)	5.1	2.2	1.2	0.5	1.3	0.9	1.0	1.1	0.8	1.0	0.9	0.9
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Boise City was irrigated, double cropped after corn, and grazed. Elk City was planted in September and grazed. Remaining locations were planted in October for grain only. Irr. = irrigated

Table 4. Grain yield in bu/a of several white wheat varieties and widely grown red wheat varieties

Entry	1998-1999				1999-2000							
	Alva	Boise City	Cherokee	Goodwell Dryland	Alva	Balko	Boise City	Cherokee	Elk City	Gage	Goodwell Dryland	Irr.
Intrada	72	87	72	84	63	28	38	51	47	28	47	57
Trego	-	-	-	-	65	29	37	44	52	33	46	66
Betty	59	75	64	68	-	-	-	-	-	-	-	-
Heyne	69	80	58	67	58	15	29	39	44	24	41	47
Oro Blanco	63	74	62	77	52	26	34	42	46	26	40	47
Custer	67	83	70	79	65	24	42	48	48	22	48	72
Jagger	72	77	76	80	66	28	39	51	48	25	39	54
2174	69	75	60	80	60	27	37	49	47	28	43	55
2137	66	74	66	-	60	25	35	55	49	27	42	50
TAM 107	-	78	-	70	-	39	32	-	-	26	49	67
Trial mean	65	78	65	79	59	26	35	47	47	27	42	57
LSD (0.05)	5	10	5	10	5	6	6	4	3	5	4	7

Boise City was irrigated, double cropped after corn, and grazed. Elk City was planted in September and grazed. Remaining locations were planted in October for grain only. Irr. = irrigated



FUTURE OF HARD WHITE WHEAT

Some premium for hard white winter over hard red winter wheat might be expected. However, even without a premium, producers could still benefit from greater diversity in market opportunities of white wheat.

As white wheat becomes more available, the uses of hard white wheat will be explored more

thoroughly. Currently at Oklahoma State University, a group of employees are working with value added products in the new Oklahoma Food and Agricultural Research and Technology Center. White wheat is one of the crops receiving attention. A noodle machine was recently acquired in the baking room. This machine will be used for research on Asian noodles. Asian noodles are becoming very popular and this could be a large market for white wheat here in Oklahoma. Continued research in utilization of white wheat is important to its success.

KEY QUESTIONS AND RESPONSES¹

¹ From "Economic Issues with White Wheat" by Michael Boland and Matthew Howe, Kansas State Univ. Agric. Expt. Sta. And Coop. Ext. Service MF-2400, April 1999 and modified for Oklahoma.

Does white wheat have enough unique features that it can be differentiated in a global wheat market?

The issue of whether a product is most profitably marketed using a differentiation strategy or a low average cost strategy is important in product development. A differentiated product retains its unique features only as long as there are no close substitutes for it uniqueness. The product's features must be great enough so that the firm can build a competitive advantage and create barriers to entry through brand loyalty. Such a strategy requires extensive marketing to sustain that brand loyalty. Once that uniqueness disappears due to substitute products with similar features, that differentiated product will be produced at the lowest possible average cost by firms that can do so. Typically, firms have difficulty in maintaining a competitive advantage through product differentiation if the market is large.

With respect to hard white wheat and hard red wheat flour, there are no significant differences with respect to protein, ash, fat, dietary fiber, and carbohydrates. The physical color of the bran is the major observable difference, but this has little, if any, economic value. The major difference appears to be in milling extraction. White wheat likely cannot be marketed as a truly differentiated product due to the presence of a close substitute (hard red wheat).

Are the new Oklahoma Agricultural Experiment Station varieties being developed for use in flour products (loaf bread, household flour, etc.) or noodles?

In the short term, the new varieties being developed by wheat breeders at the Oklahoma Agricultural Experiment Station will have protein and other properties that are likely to be most important in loaf breads. Much of the southern Great Plains hard red wheat is used in household flour, loaf bread, and other similar products. In the longer term, varieties may be adapted for use in various types of noodles.

Will these new hard white wheat varieties have the same color problems in raw noodles as hard red wheat?

Hard white wheat varieties developed for use in noodle production are being adapted to have low

amounts of polyphenol oxidase enzyme. Thus, the answer is no, discoloration will not be a major factor in future varieties being developed for noodle end uses.

What are likely to be the most significant factors that will determine adoption of hard white wheat varieties in the Great Plains?

Michael Porter's Five Forces Model is often used in analyzing an industry. The five forces are:

1. Relative strength of sellers
2. Relative strength of buyers
3. Presence of barriers to entry
4. Strength of substitutes
5. Rivalry between buyers and sellers.

Many of the Agricultural Experiment Stations and other private breeders in the Great Plains are currently committing significant resources to hard white wheat research. Buyers of hard white wheat include producers who, in the absence of a value-based marketing program, plant varieties that provide the highest yield and have traits adaptable for their geographic region. Protein is important to millers and bakers. Thus, rivalry includes trade-offs between varieties that have greater and lesser amounts of protein at various prices. However, buyers will likely be most important in hard white wheat adoption. If hard white wheat has superior milling and baking properties, then economic incentives should develop as a market with sufficient volume evolves. These incentives might include different prices for hard red and hard white wheats with different protein or other characteristics. However, if the wheat is blended or mixed, then economic incentives will not develop. Buyers are the most significant factor that will help determine whether adoption occurs.

What is the Australian Wheat Board?

Since Australia is currently the major supplier of white wheat in the world market and the primary competitor if the U.S. enters the white wheat market, some information on how white wheat is handled in Australia is presented. That Australia is able to maintain a steady share of the world wheat export market is due to its identity and quality preserved production and storage, its ability to market and export wheat of specific quality characteristics to established customers, and lower transportation costs. The Australian Wheat Board Limited (AWB) operates as the lone exporter of all wheat produced in Australia. The AWB exists as a large, specialized exporter of white wheat and differentiates its wheat by segregating its white wheat according to strict quality standards. Only exporting white wheat, along with its proximity to Southeast Asia, a large white wheat market, gives it a market advantage in this area of the world.

How does the Australian wheat Board operate?

The AWB was established after World War II under provisions of the National Security Act of 1939 to "purchase, sell and dispose of wheat and wheat products, and handle, store and ship wheat." Currently the AWB must submit a 5-year plan to the Australian government and meet the approval of the Minister of Primary Industries and Energy. The AWB evolved over the years to become the

world's largest exporter of white wheat.

What is the principal marketing difference between Australia and the United States?

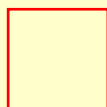
The United States has multiple exporters of wheat. U.S. wheat also is segregated by class, but wheat of the same class is blended to attain uniform quality, whereas Australian wheat is separated by quality characteristics. Australian high-protein wheat is not blended with lower-protein wheat. The high-protein wheat is stored separately from the lower-protein wheat. Thus, Australia can effectively deliver specific quality wheat rather than a few uniform blends of wheat.

CONCLUSIONS

Tradition continues to make hard red winter wheat the choice for the majority of Oklahoma wheat producers. However, hard white wheat is gradually becoming an accepted alternative crop, especially where preharvest sprouting is improbable and local marketing becomes possible.

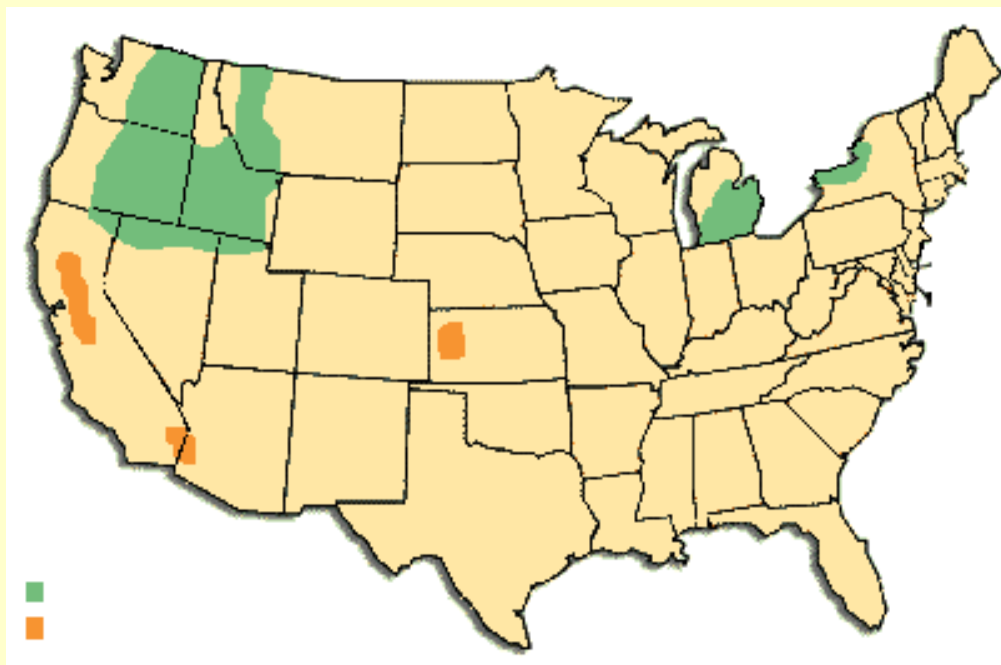
A growing global demand for white wheat has prompted some southern Great Plains growers to change. Ultimately, Kansas wheat breeders anticipate that hard white wheat will replace hard red as the accepted wheat class for that state. Oklahoma producers need not be left out. They are encouraged to begin thinking about the alternative of growing hard white wheat instead of, or in addition to, hard red wheat.

A heavy emphasis in both the Oklahoma and Kansas wheat breeding programs is on development of hard white wheat varieties with preharvest sprouting resistance equivalent to hard red wheat varieties. When this is accomplished, the potential of hard white wheat is unlimited.



U.S. WHEAT GROWING REGIONS

White Wheat

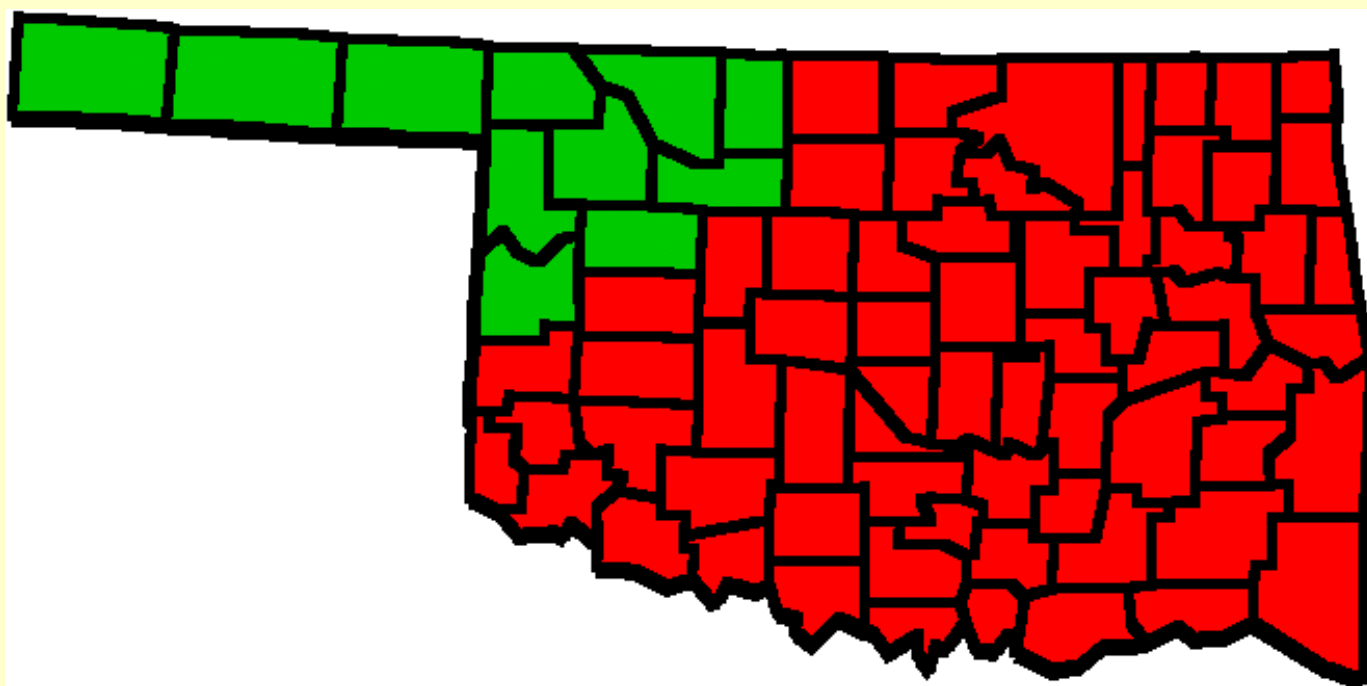


Map from National Association of Wheat Growers Wheat Facts

Figure 1 Areas of White Wheat production in the United States.

Best Adaptation of White Wheat for Oklahoma

White Wheat Discouraged



The Oklahoma Wheat Commission and Oklahoma Wheat Research Foundation are acknowledged for encouraging white wheat variety development and for their continued financial support of Oklahoma State University's wheat research and extension programs.

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