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These e-Updates are a regular weekly item from K-State Extension Agronomy and Steve Watson, Agronomy e-Update Editor. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Steve Watson, 785-532-7105 swatson@ksu.edu, or Curtis Thompson, Extension Agronomy State Leader and Weed Management Specialist 785-532-3444 cthompso@ksu.edu.

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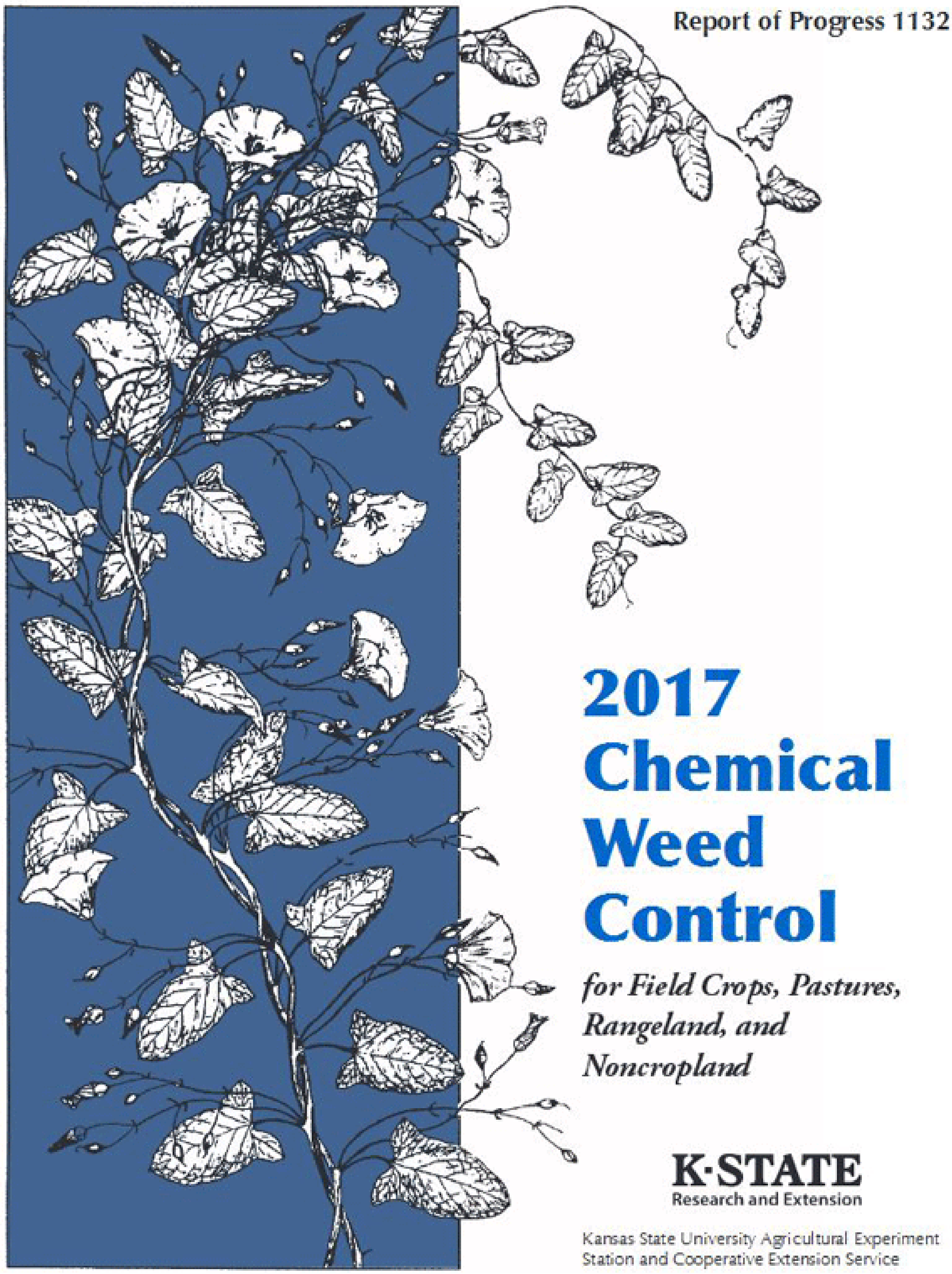
1. Preemergence herbicide programs for corn

Difficult weeds, especially glyphosate-resistant weeds, are controlled most consistently with soil-applied herbicides which kill germinating seeds/seedlings. Much of the resistance to glyphosate has developed from over-reliance on postemergence herbicide applications for weed control. Thus it is essential to include one or more of the preplant and preemergence residual herbicides available for corn. The specific herbicide you use, although important, is usually less important than just making the decision to use a preplant or preemerge herbicide.

It is important to use multiple modes of action when selecting herbicides. To assist growers, we have included in this article a reference number in parentheses that corresponds to the herbicide's mode of action. For example, the reference number herbicide mode of action for glyphosate is No. 9, and will be referred to in this article as "glyphosate (9)." There is a key to all herbicide modes of action at the end of this article. When there are two or more numbers in parentheses, it means the active ingredients in a product have different modes of action. If a herbicide is mentioned more than once in a paragraph, we include the reference number only after the first mention of the product in that paragraph.

It is important to change herbicide programs from time to time so that you do not get hooked on any single herbicide program year after year. Weed species shift and develop resistance to herbicide programs that do not change. It's also important to know the strengths and weaknesses of each product in terms of the spectrum of weeds controlled. A table summarizing weed species response to various corn herbicides can be found on pages 24-26 of *2017 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland* (SRP 1132). See: http://www.bookstore.ksre.ksu.edu/pubs/chemweedguide.pdf


Report of Progress 1132

2017 Chemical Weed Control

for Field Crops, Pastures, Rangeland, and Noncropland

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For burndown applications in a no-till system on emerged grass and broadleaf weeds, an application of glyphosate (9) and a product containing dicamba (4) or 2,4-D (4) may be critical. The choice between 2,4-D and dicamba will depend on weed species present. Dicamba products will be more effective on kochia and marestail. 2,4-D is more effective on winter annual mustards. The use of preemergence herbicides, applied just before or following planting, often provides control of weeds for several weeks. This can greatly improve the effectiveness of a postemergence herbicide application, and gives the producer more leeway on post application timing.

Categories of soil-applied residual herbicides for corn

Soil-applied residual herbicides for corn can be grouped into several basic categories.

Acetamides (15) and acetamide (15) /atrazine (5) premixes. The main acetamide (15) products used in corn include acetochlor, S-metolachlor, metolachlor, dimethamid-P, pyroxasulfone, and many premix products containing one of these active ingredients. In general, these products are very effective in controlling annual grasses (except shattercane and Johnsongrass) and small-seeded broadleaf weeds such as pigweeds. They are much less effective in controlling small-seeded kochia or large-seeded broadleaf weeds such as cocklebur, devilsclaw, morningglory, sunflower, and velvetleaf. An exception are those products containing pyroxasulfone – Zidua (15), Anthem (15, 14), and Anthem ATZ (15, 14, 5). These products have activity on kochia and the large-seeded velvetleaf. There have been no cases of weed populations in Kansas developing resistance to the acetamides to date.

The acetamide products are most effective when applied with atrazine. Several atrazine (5) /acetamide (15) premixes are available and should be used instead of acetamides alone unless atrazine is not allowed. These premixes generally fit into two groups: products with a reduced atrazine rate (1 lb or less / acre) and products with a full atrazine rate (1 to 2 lb/acre). Soil type, soil pH, and organic matter will determine whether the reduced- or full-rate atrazine product is used. In past years, often because of cost, reduced rates of these products were applied to help manage heavy summer annual grass pressure, then followed up with a good postemergence herbicide program. With the increased occurrence of glyphosate- and other herbicide-resistant weeds, it is essential to use the full rates of these products in conjunction with a POST program.

HPPD-inhibitors (27). Examples of HPPD-inhibitors are isoxaflutole (e.g. Balance Flexx (27), Corvus (27, 2), and Prequel (27, 2)) and mesotrione (e.g. Callisto (27), Callisto Xtra (27, 5), Resicore (27, 15, 4), Acuron (27, 15, 5), Lexar EZ (27, 15, 5), Lumax EZ (27, 15, 5), Acuron Flexi (27, 15), Zemax (27, 15). These products either contain atrazine or should be applied with atrazine, and are excellent on kochia, pigweeds, velvetleaf, and many other broadleaf weeds.

Acuron (27, 15, 5), Lexar EZ (27, 15, 5), Lumax EZ (27, 15, 5), Resicore (27, 15, 4) and Corvus (17, 2)+atrazine (5) provide excellent control of grass weeds. Corvus will also control shattercane. Balance Flexx has activity on shattercane but is less consistent than Corvus. Prequel has a low rate of Balance mixed with Resolve and will not provide the same level of residual weed control as Acuron, Resicore, Lexar EZ, Lumax EZ, Balance Flexx, or Corvus used at full rates. Keep in mind, products containing Balance should not be applied to coarse-textured soils when the water table is less than 25 feet below the soil surface. Balance Flexx does not provide adequate control of sunflower. Corvus will be much better than Balance Flexx on sunflower, provided the sunflower is not ALS-resistant. Herbicides containing clopyralid (4) such as Hornet (4, 2), Resicore (15, 4, 27), TripleFlex II (15, 4, 2), or Surestart II (15, 4, 2) will also provide very good control of sunflower.

A new herbicide from Syngenta called Acuron contains Lumax EZ (27, 15, 5) + bicyclopyrone (27). Bicyclopyrone is an HPPD-inhibitor herbicide that enhances large-seeded broadleaf weed control and also has grass activity. Acuron (27, 15, 5) provides enhanced control of giant ragweed, common ragweed, common cocklebur, and velvetleaf, along with improved morningglory control over Lumax EZ. An herbicide just registered in 2016 is called Acuron Flexi (27, 15) which is basically Acuron without atrazine. Acuron Flexi (27, 15) and Zemax (27, 15) which is basically Lumax without atrazine (5) were developed for areas where atrazine generally isn't used or is prohibited. Resicore will also fit in this scenario and is the most effective of the non-atrazine products in this list. Zemax and Acuron Flexi, without the atrazine (5), may provide less broadleaf weed control.

Triazine (5). Atrazine (5) is a common component of many preplant and preemergence herbicide premixes for corn. Where weed pressure is light, a March application of atrazine with crop-oil concentrate and 2,4-D (4) or dicamba (4) can control winter annual weeds such as mustards and marestail and provide control of most germinating weeds up to planting. If kochia is the key target, 0.5 to 1.0 lb/acre atrazine (5) with a pint of dicamba (4) applied in late February to early March can provide excellent control of germinating kochia. It is essential to add glyphosate (9) to the mix if winter annual grasses are present. In a premix with other herbicides, atrazine adds burndown control of newly emerged grasses and broadleaf weeds present near planting time, as well as some residual control of small-seeded broadleaf weeds such as pigweeds and kochia (except for triazine-resistant populations). Unless your situation prohibits atrazine use, always apply atrazine (5) with HPPD-inhibitor (27) and acetamide (15) herbicides.

PPO-inhibitors (14). Examples of PPO-inhibitors include flumioxazin (e.g. Valor (14), Fierce (14, 15), and saflufenacil (Sharpen (14), Verdict (14, 15). Valor or Fierce must be applied 7 to 30 days before corn planting in a no-till system. These herbicides provide excellent control of pigweeds; however, they are marginal on kochia. Fierce will provide improved control of velvetleaf compared to that from Valor. The addition of atrazine (5) will enhance kochia, pigweed, velvetleaf, and morningglory control, provided the populations are not triazine-resistant. Sharpen and Verdict have excellent activity on pigweeds, kochia, and large-seeded broadleaf weeds. However, the length of residual activity can be shorter than other preemergence products when all are compared at full rates. This will depend on the rates of Sharpen and Verdict used. Approximately 7 to 10 days of residual can be expected per 1 oz of Sharpen and 5 oz of Verdict.

ALS-inhibitors (2). Examples of ALS-inhibitors for use as a soil-applied herbicide for corn include flumetsulam, Python (2); and Hornet (2, 4), a premix of flumetsulam (2) and clopyralid (4). Both herbicides have broadleaf activity only. These products are strong on large-seeded broadleaf weeds such as cocklebur, sunflower, and velvetleaf, or the small-seeded common lambsquarters. Adding Hornet to a full rate of an acetamide (15) /atrazine (5) mix as a preemerge treatment will control the annual grasses and add considerably to large-seeded broadleaf weed control. These three-way premixes, acetochlor (15)+chlopyralid (4)+flumetsulam (2), include SureStart II (15, 4, 2) and TripleFlex II (15, 4, 2). Sunflower appears to be most sensitive to Hornet (2, 4), followed closely by cocklebur and velvetleaf. Morningglory is less sensitive. Resicore (15, 4, 27) is a new herbicide from Dow and is a premix of acetochlor (15)+chlopyralid (4)+ mesotrione (27). This product contains 3 modes of action as did SureStart II and TripleFlex II, only the ALS-inhibitor (2) has been replaced with an HPPD-inhibitor (27).

An additional ALS-inhibiting (2) herbicide from DuPont is called Resolve (rimsulfuron, 2). Rimsulfuron (2) is also a component in Prequel (2, 27), Instigate (2, 27), Basis (2), and Basis Blend (2), which was previously mentioned. Additional products containing rimsulfuron include Harrow (2) and Crusher (2). Resolve will provide short residual control of grass and broadleaf weeds and should be used as a setup herbicide with a good postemergence weed control program. If ALS-resistant broadleaf weeds are present, these ALS-containing herbicides often will be less effective.

Key to herbicide mode of action reference numbers

The Weed Science Society of America has developed a numbered classification system based on the herbicide site of action to assist farmers and applicators in selecting herbicides with different sites of action. Most herbicide labels now prominently display the herbicide classification number at the beginning of the label. Herbicide premixes that contain multiple active ingredients with different sites of action will have all sites of action numbers listed. The following list – from K-State's *2017 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland*, SRP 1132 -- presents herbicides by mode of action, chemical family, and the WSSA herbicide site of action number (in parentheses).

Amino Acid Inhibitors

ALS-AHAS inhibitors (2):

Imidazolinone family - Arsenal, Plateau, Pursuit, Raptor, Scepter, Contain, Beyond

Sulfonylurea family - Accent, Affinity, Ally, Amber, Basis, Beacon, Cimarron, Classic, Crusher, Escort, Express, Finesse, Glean, Harmony SG, Harmony Extra, Harrow, Maverick, Oust, Peak, Permit, Spirit, Steadfast, Synchrony, Telar

Triazolopyrimidine family - Python, FirstRate, PowerFlex

Sulfonylaminocarbonyl-triazolinone family - Olympus, Osprey, thiencarbazone

EPSP inhibitors (9):

Amino acid derivative family - glyphosate, Roundup, Touchdown, and others

Auxins-synthetic (4)

Benzoic acid family - Dicamba, Banvel, Clarity, DiFlexx, Status, Vision, XtendiMax, Engenia, FeXapan, and others

Phenoxy family - 2,4-D, 2,4-DB, MCPA, MCPP, 2,4-DP

Carboxylic acid family - Tordon, Stinger, Remedy, Garlon, Starane, Milestone, Trycera, StareDown, Quelex

Quinoline carboxylic acid - Facet L, Paramount, Quinstar GT, Quinstar 4L

Auxin Transport Inhibitor (19)

Semicarbazone family - diflufenzopyr

Cell Membrane Disrupters

Bipyridilium family (22) - Gramoxone, Diquat

Diphenylether family (14) - Ultra Blazer, Cobra, Phoenix, Reflex, Flexstar, ET, Vida, Dawn, Rhythm

N-Phenylphthalimide family (14) - Encompass, Resource, Valor

Aryl-Triazinone family (14) - Cadet, Spartan, Aim

Pyrimidinedione family (14) - Sharpen, Kixor

Lipid Synthesis Inhibitors (1)

Aryloxyphenoxypropionate family - Fusilade DX, Assure II, Fusion, Targa

Cyclohexanedione family - Poast, Poast Plus, Select, Volunteer, Section, Arrow, Tapout

Phenylpyrazolin family - Axial

Nitrogen Metabolism Inhibitors (10)

Organophosphorus family - Liberty

Photosynthetic Inhibitors

Triazine family (5) - atrazine, metribuzin, Princep, Evik, Pramitol

Phenylurea family (7) - Lorox, Karmex, Spike

Uracil family (5) - Sinbar, Hyvar

Nitrile family (6) - Buctril, Moxy, Bromox, Brox

Benzothiadiazole family (6) - Basagran

Pigment Inhibitors

Isoxazolidinone family (13) - Command

Isoxazole family (27) - Balance, Huskie

Triketone family (27) - Callisto, Impact, Laudis

Seedling Growth Inhibitors

Thiocarbamate family (8) - Eradicane, Eptam

Acetamide family (15) - Dual II Magnum, Define, Outlook, Propel, Surpass, Harness, Degree, Topnotch, Warrant

Pyrazole family (15) - Zidua, Anthem

Dinitroanaline family (3) - Treflan, Trust, Prowl, Acumen, Sonalan, Balan

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2. Wheat grazeout decision during the 2016-17 growing season

As the Kansas wheat crop approaches first hollow stem during the spring (see eUpdate article on identifying first hollow stem), producers who currently have cattle grazing the crop are faced with the decision of whether to graze it out or to remove the cattle and harvest the grain. This decision will be especially important in areas where the crop currently is stressed by drought; infected by virus diseases, such as wheat streak mosaic; or has a very poor stand, which is the case with many fields in southwest Kansas. Producers in areas that have been affected by wildfires may also be looking to wheat pasture as an emergency forage source. It is important that this decision is taken prior to first hollow stem, as grazing past first hollow stem will decrease the wheat yield potential by as much as 5% per day.

Factors affecting the decision of whether to graze out or harvest for grain yield include estimates of future wheat grain yield, prices of wheat and beef, stocking rate and stocker gains, weather, and grazing length during the spring. Most of these factors are field-specific and need to be customized for each producer-field situation. The paragraph below offers some insight on some of the factors above.

Potential grain yield

Wheat grain yield cannot be estimated with complete accuracy at this early stage of growth. However, there are ways to make a good estimate. A good start is to look at the yield record from the last 5-10 years for each field. The long-term average yield can provide a good estimate of expected yield from a particular field, and the expectations for this year's crop. If wheat has never been grazed during the last 5-10 years, producers should account for a 10-15% yield decrease if they plan to graze their crop and take it for grain this year. Another tool producers can use is a handheld active optical sensor that measures the crop's NDVI, which is a method of quantifying the crop's current condition.

Years of research at K-State demonstrated that an optical sensor measurement, when taken at spring greenup or Feekes GS 4, can be used with a certain degree of confidence to estimate wheat yield potential. Given the dry conditions and poor wheat stands in most of the western region of the state, the yield potential will most likely be below average. Producers will need to consider whether it would be better to graze these fields out or potentially receive a lower yield and potential crop insurance payment. Grazing past the insurance deadline will make the crop ineligible for an insurance claim.

Stocking rate and stocker gains

When planning to harvest the crop for grain, stocking rates should be conservative to preserve the crop's yield potential, generally ranging from 250 to 500 pounds of live animal per acre. Producers who will graze out the crop can increase these rates during the spring, usually to as much as 1,000 pounds of live animal per acre. Average stocker gains range from 1.5 to 2.5 pounds per day, which in part depends on the amount of forage available.

Weather

The weather will be an important factor dictating the wheat's recovery from grazing, when planning to harvest the crop. Growing seasons characterized by cool and moist early spring (following grazing termination) will favor crop recovery and help minimize any yield penalty from grazing. Hot and dry early springs (like we are currently experiencing) will increase the yield penalty associated with grazing as the crop will be less likely to recover the leaf area prior to jointing. Yield potential will be reduced under those circumstances.

Grazing length during the spring

Soil temperatures during the spring dictate how soon the crop reaches first hollow stem, the critical period for removing cattle from wheat fields that will be taken for grain. Air temperature during the 2017 spring have been above normal for the majority of the state (see eUpdate on that issue here). This has increased soil temperatures and as a consequence, sped up crop development. Most varieties have already reached first hollow stem at several Oklahoma locations, and many varieties are approaching this stage in Kansas (for an update on different varieties and first hollow stem, see eUpdate here). Most likely, producers interested in harvesting the crop for grain will have to remove cattle in early March for the majority of the state, which is earlier than other years on record. The early removal of cattle from wheat pastures this year will play an important role when comparing budgets for the dual-purpose versus grazeout system, as producers wanting to harvest the grain in a dual-purpose system will have less time to graze during the spring. Again, also follow your insurance deadline for removing cattle, which may occur prior to first hollow stem.

Scenario analysis

Producers are encouraged to perform a scenario analysis based on each field's history. For instance, exploring low grain/forage yields, versus average grain/forage yields, versus high grain/forage yields, might be helpful. Two different scenarios are explored in the following paragraphs. These scenarios assume stocker cattle are already grazing on the field and the producer is trying to decide whether to graze out the wheat or to harvest it for grain (pulling the cattle off now). The partial budget below explores potential costs and income differences if making the graze-out decision. Producers can download the spreadsheet perform the analysis for their own system here. All inputs in blue should be adjusted to fit the producer's own scenario.

a. **Average forage yield, and low, average, or high grain yield scenarios.**

In the example shown on Figure 1, three different grain yield scenarios are explored: 20, 30, or 40 bushels per acre, with average forage yield and all other factors maintained constant. In this example, the only scenario in which maintaining the crop for grain paid out was with a yield potential of 40 or more bushels per acre.

Wheat grain income given up by graze-out is currently valued at $4.00 a bushel, multiplied by 20, 30, and 40-bushel yield scenarios. Assuming a producer insured this wheat crop at 70%, a 20-bushel yield scenario would produce a small crop insurance payment. The producer will also be giving up this payment if grazing the wheat out, so it is deducted from potential income. By grazing the wheat out, some agronomic costs will be reduced. Obviously, there will not be harvesting, hauling, or drying costs. The producer could also save application and chemical costs of fungicide, if they were planning to apply a fungicide for the grain crop. Herbicides would not be needed, so the default budget takes out the chemical costs but leaves the application cost in since the herbicide is normally applied with fertilizer.

If choosing grazeout, the producer will also save 65% of the crop insurance premium (note that the agent must be notified by March 15th). Using default values in the spreadsheet, this adds up to a per acre savings of $72.80. Additional fertilizer is recommended to improve forage yields, however, so this additional cost is applied using the formula of 30 additional pounds of N per 100 pounds of beef being grazed per acre. Nitrogen is valued at $0.35 per pound.

Summing up all of these changes to a normal wheat grain budget, the producer is giving up $24.69, $59.80, and $99.80 per acre, respectively, on the 20, 30, and 40-bushel potential yield scenarios. As a side note, this would be the minimum the producer would want to charge to lease the field out for grazing, or they would be better off harvesting it for grain.

Figure 1. Partial budget analysis using different grain yield level scenarios, all else constant.

Partial Budget of Wheat Graze-out vs. Grain Harvesting								
						Low Grain/Forage Yield	Average Grain/Forage Yield	High Grain/Forage Yield
Loss of Grain Sales				Yield in bu/acre		20	30	40
		Reduced Income at	$4.00	per bushel		($80.00)	($120.00)	($160.00)
			Crop Insurance Payment			($4.89)	$0.00	$0.00
Reduced Input Costs								
	Crop Insurance		$7.80	per acre				
	Havesting/Hauling/Drying		$35.00	per acre				
	Fungicide Chemical & Application		$20.00	per acre				
	Herbicide Chemical		$10.00	per acre	=	$72.80	$72.80	$72.80
Increased Input Costs								
	Additional fertilizer?	Yes				(12.60)	(12.60)	(12.60)
Loss in income per acre by grazing instead of harvesting						**(24.69)**	**(59.80)**	**(99.80)**
Potential Cattle Income								
	March Price	$132.00						
	March Weight	700	$924.00					
	May Price	$125.00						
	May Weight	820	$1,025.00					
	Death Loss	$18.48						
			$82.52	per animal				
Additional Cattle Costs								
	Mineral	$3.00						
	Labor/Machinery	$13.00						
	Other	$5.00						
		Total	($21.00)	per animal				
		Income	**$61.52**	**per animal**				
				Stockers per acre	=	1.0	1.0	1.0
				Stocker income		$61.52	$61.52	$61.52
Return per Acre for grazing out vs. harvesting for grain						**$36.83**	**$1.72**	**-$38.28**

To bring in the potential cattle income and costs, if the stockers are sold today at 700 pounds, they could receive around $132 per cwt. By grazing them on wheat pasture until the middle of May, they could gain 120 pounds (2 pound ADG) and be potentially sold for $125 per cwt. Assuming a 2% death loss on their current value, this gives a potential income of $82.52 per animal by grazing them until May. Additional costs of mineral, labor/machinery, etc. should be applied if they differ from what would have been performed anyway. For example, hauling and marketing costs would be incurred whether the stockers are sold now or in May, so they are not applied. The default values show potential returns of $61.52 per animal after costs.

The number of stockers per acre ties the animal income and per acre costs together. Figure 1 uses one acre per stocker animal across all yield scenarios. The default values in the spreadsheet show that for both the low and normal yielding scenarios, this producer would be better off grazing-out the wheat than pulling the cattle now and carrying the crop out for grain. Only the high-yielding scenario would pencil out better as a grain crop.

a. **Low, average, or high forage and grain yields scenarios**

As another scenario, Figure 2 shows an example to where the producer already has an indication that the wheat crop may be heading towards one of the three yield categories. This example is the same as Figure 1 except that stocking rate varies from 0.7 stockers per acre in the low-forage scenario to 1.3 stockers per acre in the high-forage scenario. This analysis also assumes changes in fertilizer recommendations to the wheat forage. In this scenario, the producer is anticipating one of the three yield categories and is changing management decisions to match expectations. The bottom line recommendations come out the same -- with the high yield scenario it would be better to carry the wheat out to harvest and with the other scenarios it would be more economical to grazeout.

Figure 2. Partial budget analysis using different grain yield level scenarios, varying stocking

Partial Budget of Wheat Graze-out vs. Grain Harvesting

						Low Grain/Forage Yield	Average Grain/Forage Yield	High Grain/Forage Yield
Loss of Grain Sales				Yield in bu/acre		20	30	40
		Reduced Income at	$4.00	per bushel		($80.00)	($120.00)	($160.00)
			Crop Insurance Payment			($4.89)	$0.00	$0.00
Reduced Input Costs								
	Crop Insurance		$7.80	per acre				
	Havesting/Hauling/Drying		$35.00	per acre				
	Fungicide Chemical & Application		$20.00	per acre				
	Herbicide Chemical		$10.00	per acre	=	$72.80	$72.80	$72.80
Increased Input Costs								
	Additional Fertilizer?	Yes				(8.82)	(12.60)	(16.38)
Loss in income per acre by grazing instead of harvesting						**(20.91)**	**(59.80)**	**(103.58)**
Potential Cattle Income								
	March Price	$132.00						
	March Weight	700	$924.00					
	May Price	$125.00						
	May Weight	820	$1,025.00					
	Death Loss	$18.48						
			$82.52	per animal				
Additional Cattle Costs								
	Mineral	$3.00						
	Labor/Machinery	$13.00						
	Other	$5.00						
		Total	($21.00)	per animal				
		Income	**$61.52**	**per animal**				
				Stockers per acre	=	0.7	1.0	1.3
				Stocker income		$43.06	$61.52	$79.98
Return per Acre for grazing out vs. harvesting for grain						**$22.15**	**$1.72**	**-$23.60**

rates and fertilizer rates

Planting a spring crop after wheat grazeout

Another key item to consider is that by grazing out wheat, a spring crop could be planted, if desired and if herbicide carryover considerations allow. Crop insurance final planting dates for soybeans and grain sorghum both leave an adequate window to do this (again, the crop insurance agent needs to be notified by March 15th). Depending on moisture conditions, this might even make the high-yielding scenario attractive to grazeout instead of carrying the crop to grain yield, as the reduced income could be made up for with returns from another crop.

Download of partial budget spreadsheet

Producers are encouraged to download the spreadsheet used in the two examples above (here) and run their own numbers before they make this decision. Uncertainties exist in yield, wheat and cattle prices, cattle performance, etc., so those risks should be considered by being conservative on estimates or performing "what-if" scenarios. If any doubts exists on the use of this spreadsheet, don't hesitate to contact one of the specialists listed below.

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3. Corn seeding rate recommendations

The optimal corn seeding rate for any situation will depend on the anticipated environment and how the hybrid responds to that environment. Thus, optimum seeding rate depends on the hybrid (genotype, G) and the interaction with the environment (E), in something that researchers want to term as the G x E interaction. Producers can look back to their corn crop from the previous growing season, or wait until the current growing season is nearly complete, and evaluate whether the population they used was adequate. Another factor that sometimes we neglected to mention is the effect of management practices (M component). Planting date, row spacing, crop rotations can also exert some influence on the yield response to the plant population factor.

Individual hybrids can respond differently, but the following guidelines may help in deciding if current seeding rates need to be adjusted. If more than about 5% of the plants are barren or if most ears have fewer than 250 kernels per ear, the population may be too high. If there are consistently more than 600 kernels per ear or if most plants have a second ear contributing significantly to grain yield, the population may be too low. Of course the growing conditions will influence ear number and ear size as well, so it is important to factor in the growing conditions for that season when interpreting these plant responses. In addition to the growing conditions, nutrient status can also exert some influence on the final number of grains per ear. For example, severe nitrogen (N) deficiency will have a high impact on the final number of grains, ear size and ear number.

Don't be too concerned if a half-inch or so of the ear tip has no kernels. If kernels have formed to the tip of the ear, there may have been room in that field for more plants contributing to grain yield. Again, "tipping back" will vary with the G x E x M interaction. Potential ear size and potential number of kernel (1,000-1,200 per ear) are set before silking, but the actual final number of kernels is not determined until after pollination and early grain fill (lack of fertilization and early abortion of grain number).

Always keep the long-term weather conditions in mind. In a drought year, almost any population is too high for the available moisture in some areas. Although it's not a good idea to make significant changes to seeding rates based only on what has happened recently, it is worthwhile taking into consideration how much moisture there is currently in the soil profile and the long-term forecasts for the upcoming growing season.

Making a decision on whether to keep seeding rates at your usual level or cutting back somewhat this year if the soil profile is drier than normal is a little like the famous line in the movie Dirty Harry: "How lucky do you feel?" If you think weather conditions will be more favorable for corn this year than the past years, stay about in the middle to upper part of the range of seeding rates in the table below. If you do not think growing conditions will improve enough to make up for dry subsoils, you might want to consider going toward the lower end of the range of recommended seeding rates, with the caveat that if growing conditions improve you will have limited your top-end yield potential.

Optimal seeding rates may need to be adjusted for irrigated corn if fertilizer or irrigation rates are sharply increased or decreased. For example, research at the Irrigation Experiment Field near Scandia has shown that if fertilizer rates are increased, seeding rates also have to be increased to realize the maximum yield benefit. Consult seed company recommendations to determine if seeding rates for specific hybrids should be at the lower or upper end of the recommended ranges for a given environment.

The recommended planting rates in the following tables attempt to factor in these types of questions for the typical corn growing environments found in Kansas. Adjust within the recommended ranges depending on the specific conditions you expect to face and the hybrid you plan to use.

The following recommend planting rates are from the K-State Corn Production Handbook.

Suggested Dryland Corn Final Populations and Seeding Rates			
Area	Environment	Final Plant Population (plants per acre)	Seeding Rate*
Northeast	100-150 bu/a potential	22,000-25,000	26,000-29,500
	150+ potential	24,000-28,000	28,000-33,000
Southeast	Short-season, upland, shallow soils	20,000-22,000	23,500-26,000
	Full-season bottomground	24,000-26,000	28,000-30,500
Northcentral	All dryland environments	20,000-22,500	23,500-26,500
Southcentral	All dryland environments	18,000-22,000	21,000-26,000
Northwest	All dryland environments	16,000-20,000	19,000-23,500
Southwest	All dryland environments	14,000-20,000	16,500-23,500

Suggested Irrigated Corn Final Populations and Seeding Rates			
Environment	Hybrid Maturity	Final Plant Population (plants per acre)	Seeding Rate*
Full irrigation	Full-season	28,000-34,000	33,000-40,000
	Shorter-season	30,000-36,000	35,000-42,500
Limited irrigation	All	24,000-28,000	28,000-33,000

* Assumes high germination and that 85 percent of seeds produce plants. Seeding rates can be reduced if field germination is expected to be more than 85%.

For more information, see the K-State Corn Production Handbook, C-560:
http://www.ksre.ksu.edu/library/crpsl2/c560.pdf

For the new corn genetics technology, the drought-tolerant (DT) hybrids have become available in recent years and questions about whether changes in seeding rates are needed with these new hybrids are becoming more frequent. A summary of information is in preparation as regarding the evaluation of DT vs. non-DT corn hybrids at different site-years around the state of Kansas (West, Northcentral, Eastern locations). From the evaluation performed in these site-years evaluating diverse seeding rates, hybrids, and water usage, differences in yield were observed when DT corn hybrids were compared with non-DT materials. Still, the most important point, as presented in the below figure, is that the yield response at plant-scale to plant population is similar for DT vs. non-DT corn hybrids (share equal slope). Thus, a change in plant population doesn't seem to be needed with DT hybrids.

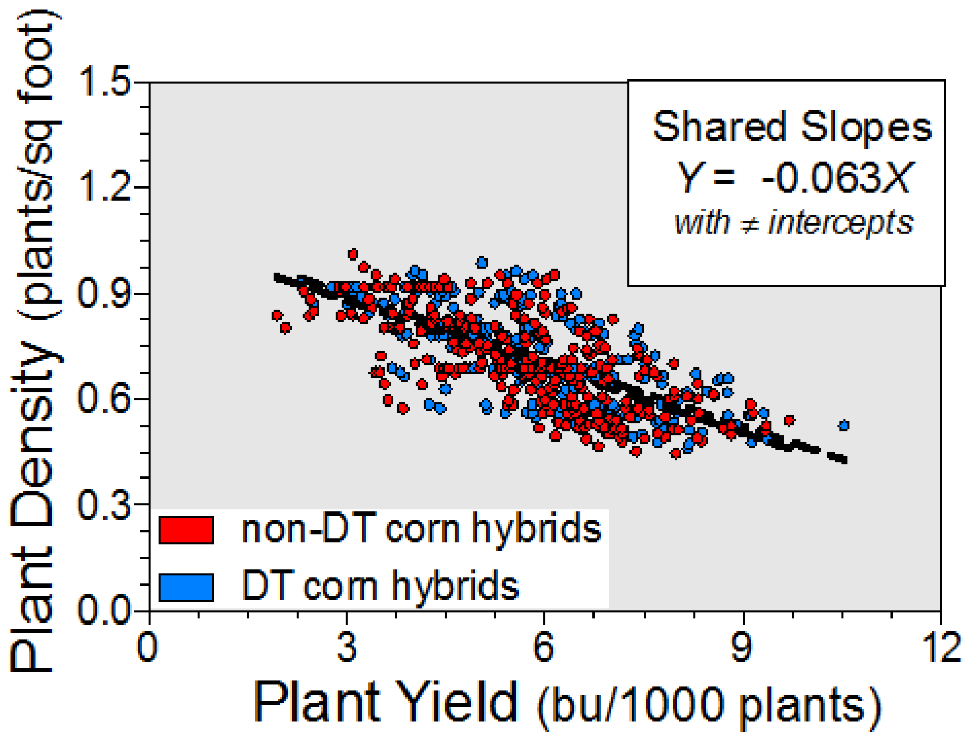

Figure 1. Plant-scale association between plant density or plant population (plants per square foot) and the plant yield (in bushels per 1,000 plants) [Adee, Balboa, Roozeboom, Schlegel, and Ciampitti].

New Research on Corn Seeding Rates

An intensive review of a large database from Dupont Pioneer (2000-2014 period) was utilized to synthesize yield response to plant population under varying yield environments (<100 bu/acre to >200 bu/acre). Overall, across the four different hybrids evaluated, yield response to plant population depended on the final yield environment (Fig. 2). In yield environments below 100 bu/acre, yield response to plant population was slightly negative. Yield response to plant population tended to be flat when yield environment ranged from 100 to 150 bu/acre; positive and quadratic with the yield environment improving from 150 to 180 bu/acre; and lastly, increasing almost linearly with increasing plant populations when the yield environment was more than200 bu/acre (Fig. 2).

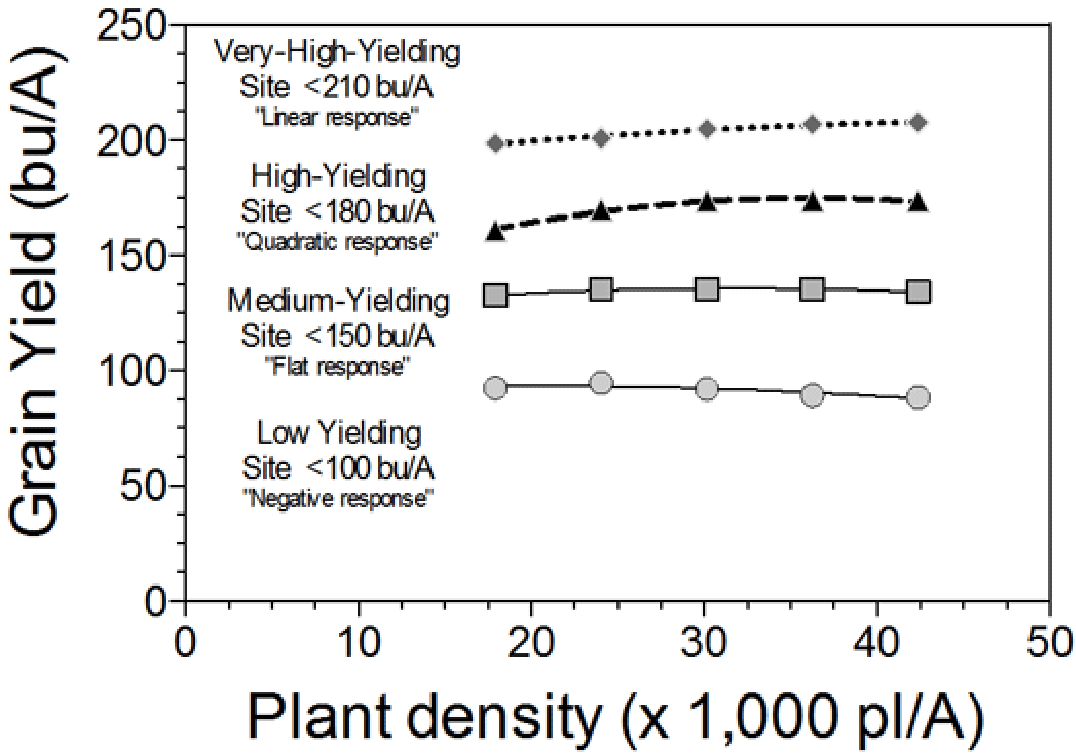

Figure 2. Corn grain yield response to plant density in four different productivity environments, a) low yielding <100 bu/acre; b) medium yielding 100-150 bu/acre; c) high yielding 150-180 bu/acre; and d) very high yielding 190-210 bu/acre (Assefa et al., 2016, Crop Science Journal).

As a disclaimer, "agronomically" optimum plant population does not always coincides with the "economically" optimal plant population. Therefore, farmers should consider this aspect when deciding the final seeding rate for corn. In addition, as previously mentioned, final seeding rate depends on the environment, hybrid utilized, and production practices selected (e.g., planting date). Producers should consider looking at the previous crop to investigate if the seeding rate previously used in their different fields was adequate for their respective yield environments.

More information on the on-farm studies, seeding rates, and new corn hybrid technology will be summarized in future issues of the Agronomy e-Update. Stay tuned.

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4. First hollow stem update: March 10, 2017

Cattle should be removed from wheat pastures when the crop reaches first hollow stem (FHS).

Grazing past this stage can severely affect wheat yields (for a full explanation, please refer to *e*Update article "Optimal time to remove cattle from wheat pastures: First hollow stem."

First hollow stem update

In order to screen for FHS during this important time in the growing season, the K-State Extension Wheat and Forages crew measures FHS of 20 different commonly grown wheat varieties and experimental lines in Kansas. The varieties are in a September-sown replicated trial at the South Central Experiment Field near Hutchinson, in cooperation with Gary Cramer, Agronomist-in-Charge of the Field.

Ten stems are split open per variety per replication, for a total of 40 stems monitored per variety. The average length of hollow stem is reported for each varieties in Table 1.

Table 1. Length of hollow stem measured March 9, 2017 of 20 wheat varieties and experimental lines sown mid-September 2016 at the South Central Experiment Field near Hutchinson. The critical FHS length is 1.5 cm (about a half-inch or the diameter of a dime).

Variety	Hollow stem length (cm)				
	2/17/2017	2/22/2017	3/3/2017	3/5/2017	3/10/201
1863	0.02	0.26	0.42	0.95	**1.58**
Bentley	0.03	0.17	0.25	0.44	**0.44**
Doublestop CL Plus	0.02	0.16	0.20	0.51	**0.59**
Everest	0.04	0.23	0.38	0.83	**1.30**
Gallagher	0.05	0.33	0.58	0.97	**1.53**
Iba	0.03	0.31	0.38	0.72	**1.01**
KanMark	0.04	0.22	0.34	1.00	**0.87**
KS061193K-2	0.03	0.33	0.34	1.02	**1.04**
KS080448C*102	0.01	0.06	0.33	0.51	**0.57**
Larry	0.03	0.16	0.18	0.57	**0.56**
OK11D25056[1]	0.02	0.18	0.44	0.76	**0.99**
OK12716	0.03	0.20	0.27	0.66	**0.77**
OK12DP22002-042	0.03	0.19	0.40	0.89	**1.30**
Ruby Lee	0.02	0.20	0.27	0.82	**1.16**
Stardust	0.02	0.34	0.53	1.01	**1.13**
SY Flint	0.03	0.30	0.46	0.96	**1.12**
SY Grit	0.02	0.22	0.48	1.06	**1.53**

SY Llano	0.01	0.38	0.60	1.39	**2.67**
Tatanka	0.03	0.18	0.35	0.50	**0.51**
Zenda	0.04	0.30	0.36	1.02	**0.93**

[1] OK11D25056 will be released as "Smith's Gold"

As of March 9th, four varieties had reached first hollow stem (Figure 1), and all varieties are showing some degree of stem elongation. SY Llano, SY Grit, Gallagher, and 1863 are all past first hollow stem, averaging a minimum of 1.53 cm. Producers growing these varieties in south central Kansas should have already removed cattle by now, unless intending to graze out the crop (please see accompanying article "Wheat grazeout decision during the 2016-17 growing season" in this March 10, 2017 issue of the Agronomy eUpdate). Other varieties rapidly approaching first hollow stem are Everest, Iba, Stardust, Ruby Lee, and SY Flint.

The remaining varieties are elongating stem at a slower rate and have now less than 1.0 cm. Still, first hollow stem will be achieved within a few days for all of the varieties being evaluated. Thus, producers should keep a closely monitor first hollow stem in their wheat pastures at this time.

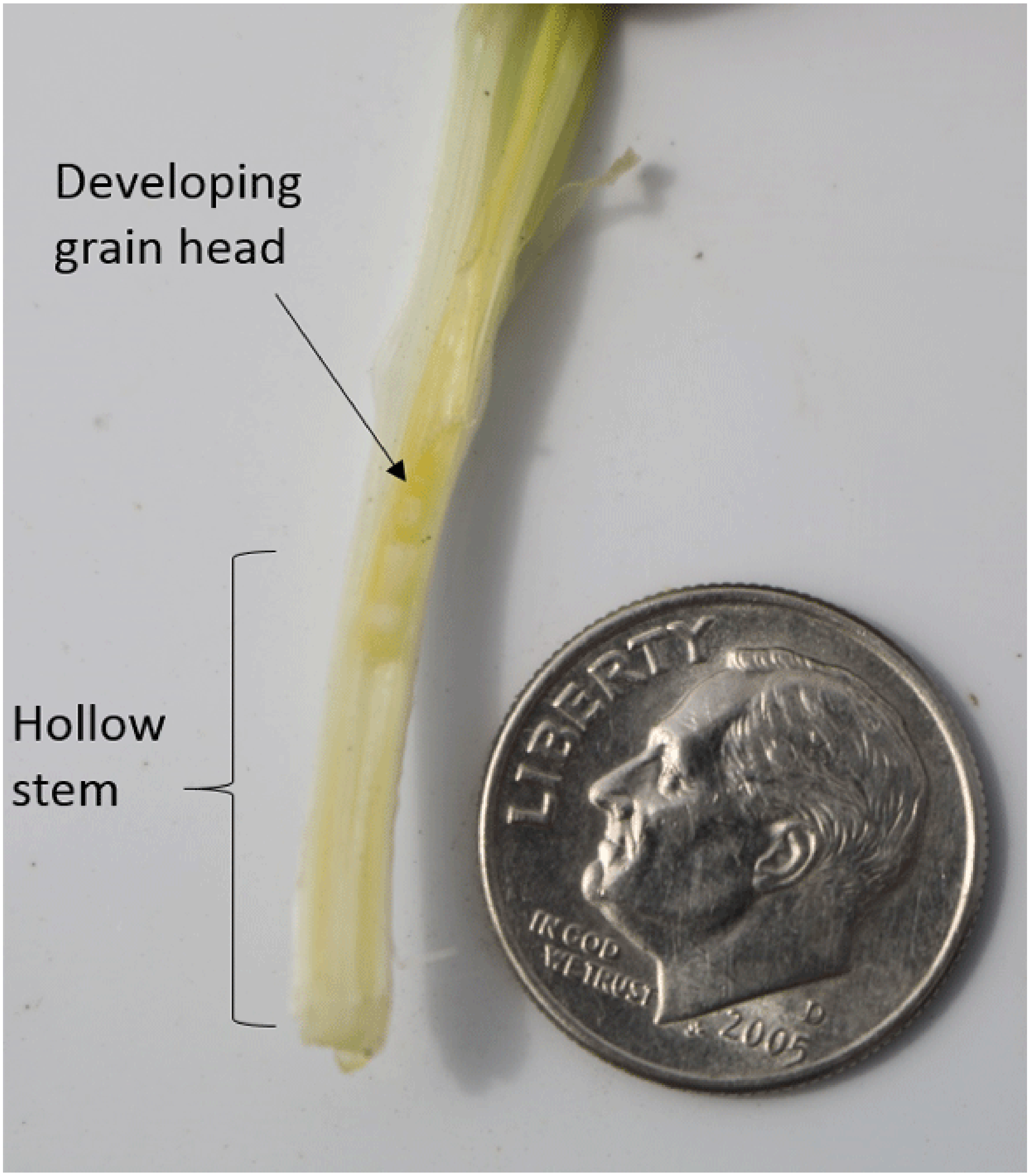

Figure 1. Depiction of the first hollow stem stage or growth in wheat. Photo by Romulo Lollato, K-State Research and Extension.

How do these values compare to other growing seasons for Kansas?

Unfortunately, we do not have a history of first hollow stem measurements in Kansas to which we can compare these averages. Our best benchmark is the 2015-16 growing season, which was the first year of these measurements in Hutchinson. That season was also characterized by a mild winter and the wheat was approximately 2 weeks ahead of its normal growing cycle at this point. During the 2015-16 growing season, all varieties evaluated reached first hollow stem between March 5th and 9th. In the current season, only the very early varieties reached this threshold by the same day of the year. Thus, the wheat during the 2016-17 growing season seems to be slightly behind in development as compared to the previous year, but still ahead of what would be normal.

The intention of this report is to provide producers a weekly update on the progress of first hollow stem development in different wheat varieties. Producers should use this information as a guide, but it is extremely important to monitor FHS from an ungrazed portion of each individual wheat pasture to take the decision of removing cattle from wheat pastures.

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5. Comparative Vegetation Condition Report: February 28 – March 6

The weekly Vegetation Condition Report maps below can be a valuable tool for making crop selection and marketing decisions.

The objective of these reports is to provide users with a means of assessing the relative condition of crops and grassland. The maps can be used to assess current plant growth rates, as well as comparisons to the previous year and relative to the 27-year average. The report is used by individual farmers and ranchers, the commodities market, and political leaders for assessing factors such as production potential and drought impact across their state.

The Vegetation Condition Report (VCR) maps were originally developed by Dr. Kevin Price, K-State professor emeritus of agronomy and geography, and his pioneering work in this area is gratefully acknowledged.

The maps have recently been revised, using newer technology and enhanced sources of data. Dr. Nan An, Imaging Scientist, collaborated with Dr. Antonio Ray Asebedo, assistant professor and lab director of the Precision Agriculture Lab in the Department of Agronomy at Kansas State University, on the new VCR development. Multiple improvements have been made, such as new image processing algorithms with new remotely sensed data from EROS Data Center.

These improvements increase sensitivity for capturing more variability in plant biomass and photosynthetic capacity. However, the same format as the previous versions of the VCR maps was retained, thus allowing the transition to be as seamless as possible for the end user. For this spring, it was decided not to incorporate the snow cover data, which had been used in past years. However, this feature will be added back at a later date. In addition, production of the Corn Belt maps has been stopped, as the continental U.S. maps will provide the same data for these areas. Dr. Asebedo and Dr. An will continue development and improvement of the VCRs and other advanced maps.

The maps in this issue of the newsletter show the current state of photosynthetic activity in Kansas, and the continental U.S., with comments from Mary Knapp, assistant state climatologist:

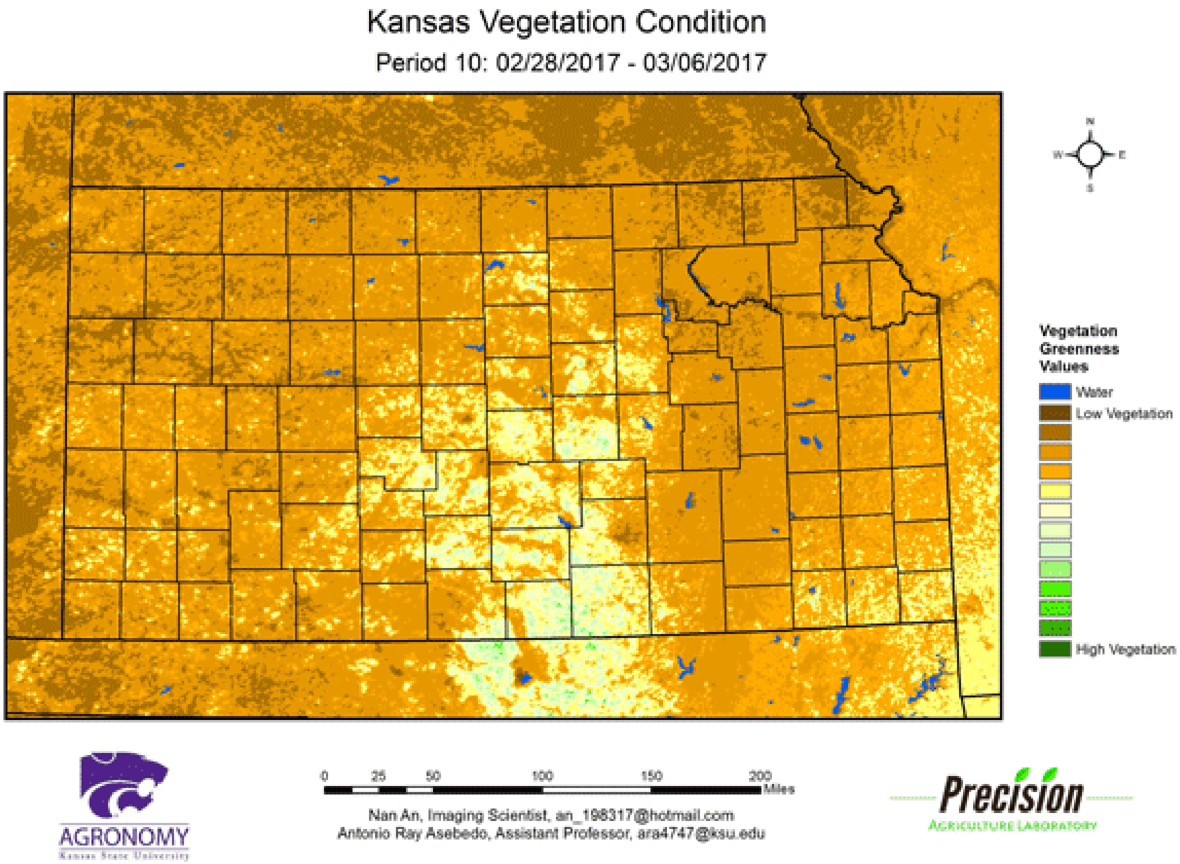

Figure 1. The Vegetation Condition Report for Kansas for February 28 - March 6, 2017 from K-State's Precision Agriculture Laboratory shows only light photosynthetic activity. The little production is mainly in central Kansas, although it continues to expand northward. This is not unexpected even with the warmer-than-normal temperatures. Low temperatures are still falling below freezing and average soil temperatures are approaching the 50-degree range.

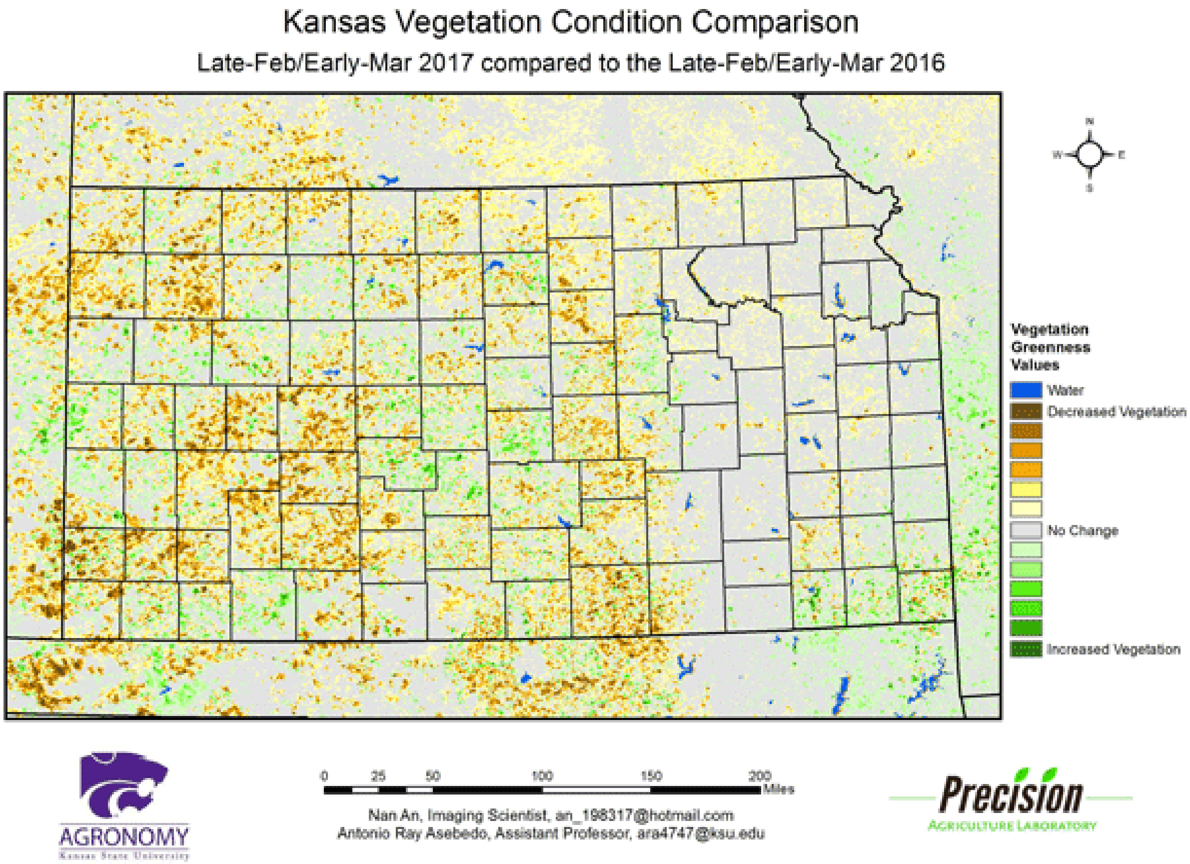

Figure 2. Compared to the previous year at this time for Kansas, the current Vegetation Condition Report for February 28 - March 6, 2017 from K-State's Precision Agriculture Laboratory shows much lower NDVI values across southern Kansas. The winter wheat is less advanced this year than last, particularly in western Kansas, where dry fall conditions hampered establishment.

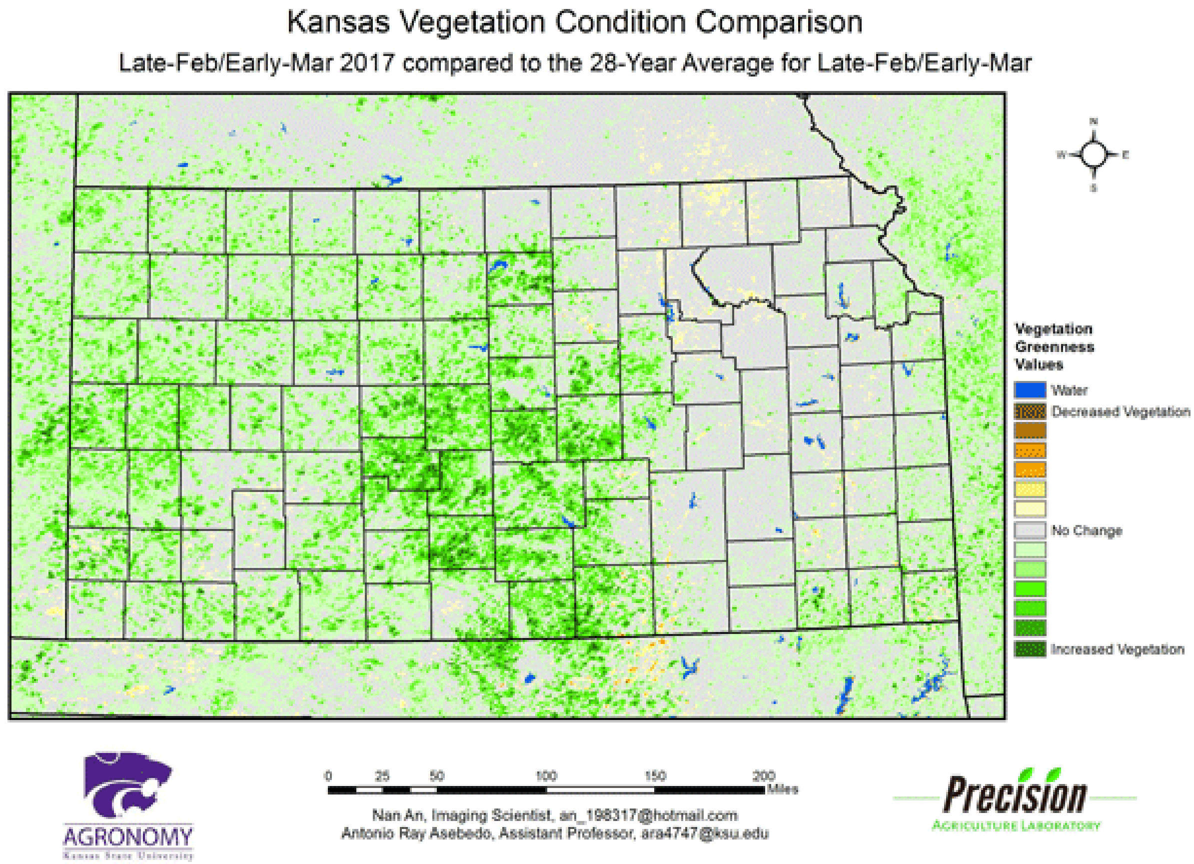

Figure 3. Compared to the 27-year average at this time for Kansas, this year's Vegetation Condition Report for February 28 - March 6, 2017 from K-State's Precision Agriculture Laboratory much of the state has above-normal vegetative activity. The highest NDVI values are in the central and south central parts of the state, where precipitation has been more favorable.

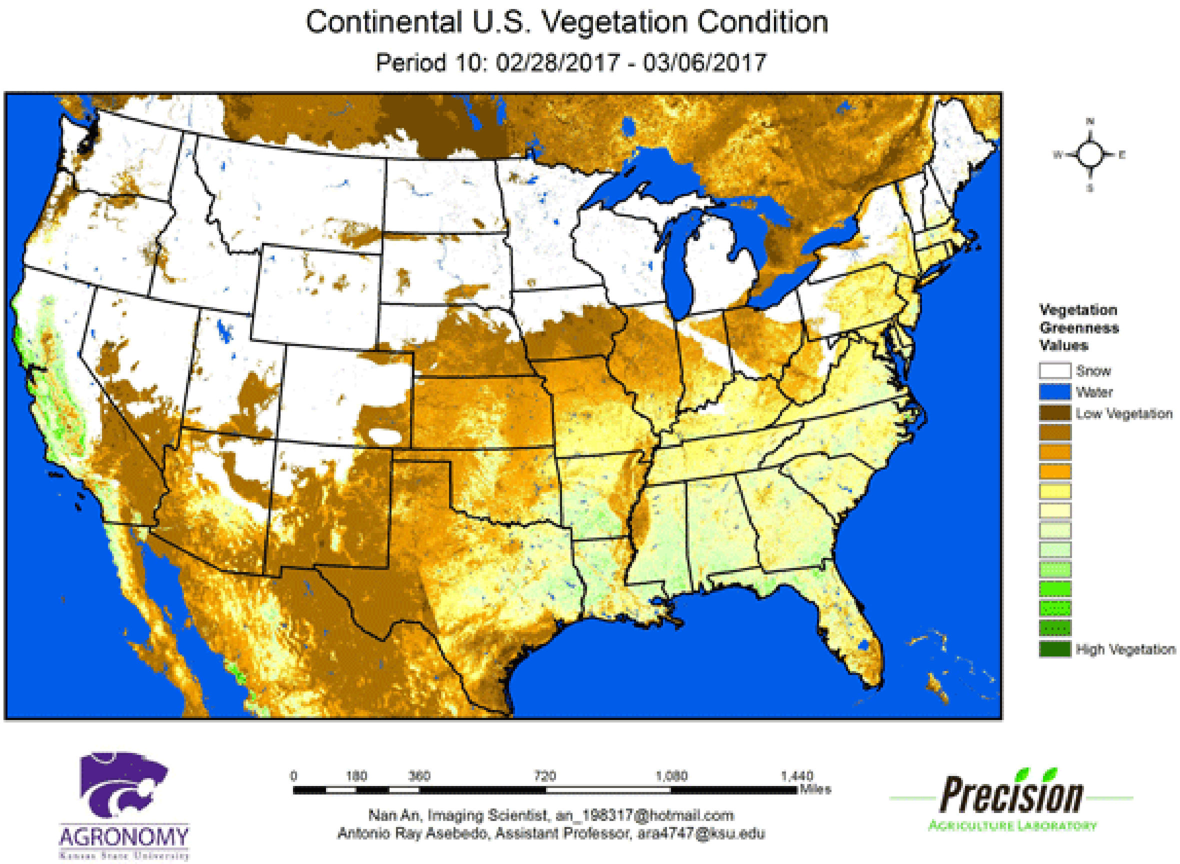

Figure 4. The Vegetation Condition Report for the U.S for February 28 - March 6, 2017 from K-State's Precision Agriculture Laboratory shows highest NDVI confined to the South, particularly in east Texas and Louisiana. Snow coverage continues to retreat to the north, with a small pocket in Northeastern Colorado. The Sierra Nevada of California continues with record snowpack, and snow returned to the Great Lakes and Upper New England regions.

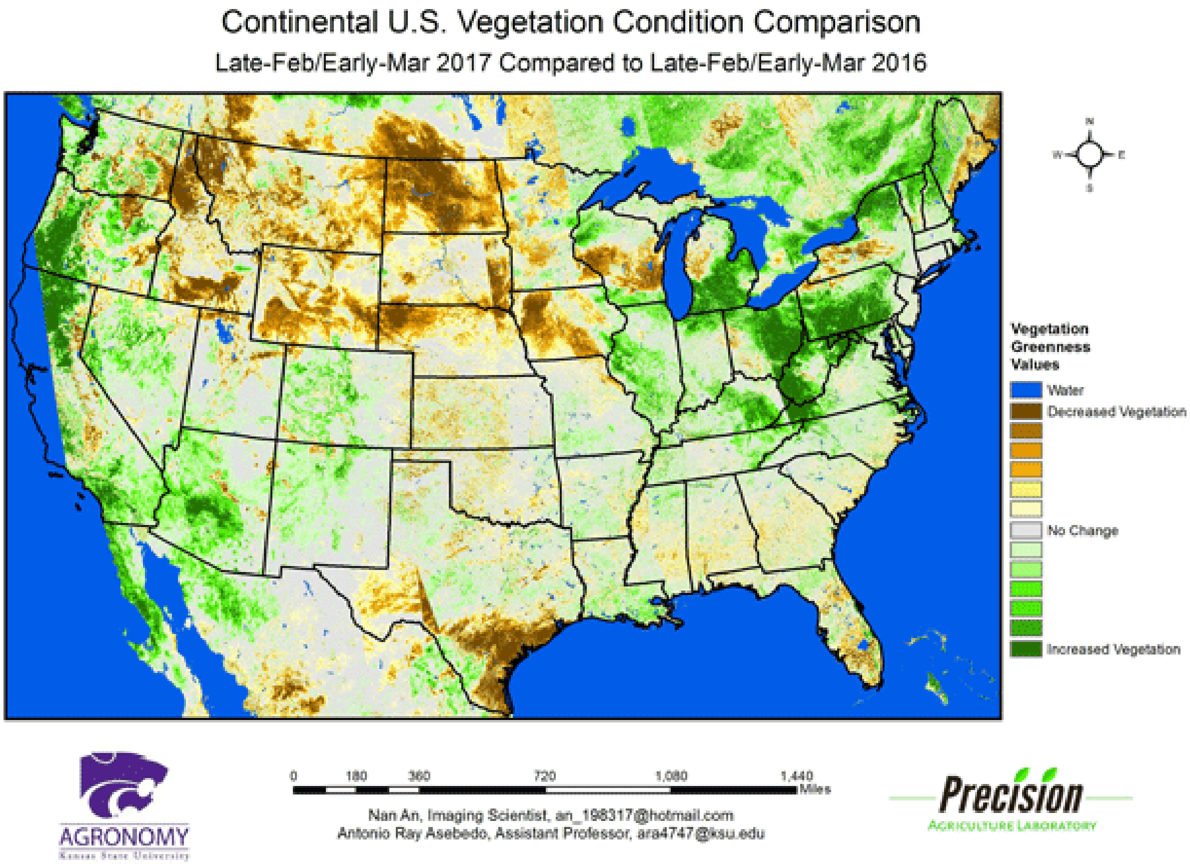

Figure 5. The U.S. comparison to last year at this time for February 28- March 6, 2017 from K-State's Precision Agriculture Laboratory shows the impact that split in the snow cover has caused. Much lower NDVI values prevail from the Pacific Northwest through the northern Plains, where snow coverage continues to be much higher this year. In contrast, the region along the Great Lakes, has seen much lower snowfall. This, coupled with warmer than average temperatures, has favored early vegetative growth.

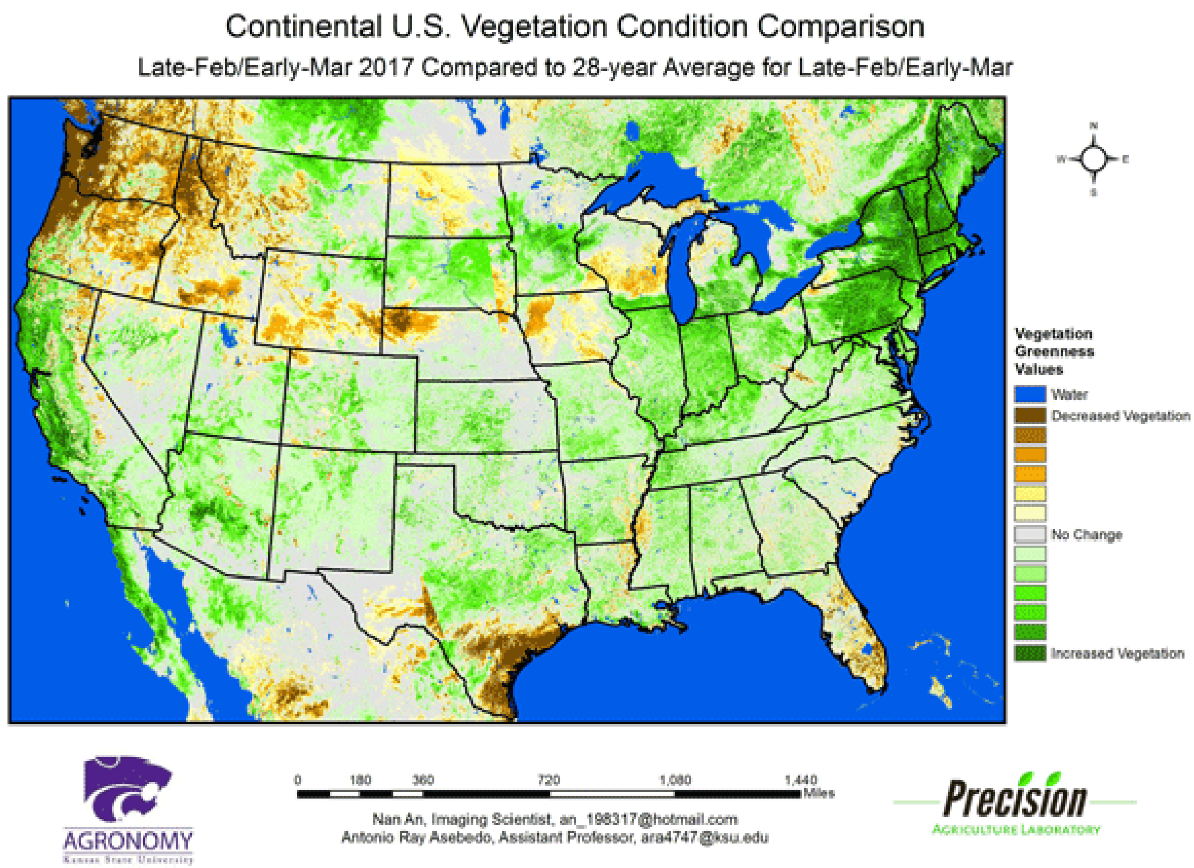

Figure 6. The U.S. comparison to the 27-year average for the period of February 28- March 6, 2017 from K-State's Precision Agriculture Laboratory shows the area of lowest photosynthetic activity is in the Intermountain West, where snow cover is greatest. Higher NDVI values are visible in the Midwest from Iowa through Pennsylvania and northward. Warmer than normal temperatures and little snow cover has favored early vegetative growth with increased risk of freeze damage.

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