FOCUS on South Plains Agriculture

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Special Edition: Wheat Freeze Injury and Assessment

By Calvin Trostle, Extension Agronomist

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Introduction

I have been through this freeze injury several times, but I have learned the more this year than ever before. I want to reassure all that assessing freeze injury is not easy, and don't feel bad if you are having trouble getting a handle on what you are looking at. That is a routine feeling, it seems. Sometimes it is highly useful after an assessment to revisit the field or a sample from it for a follow-up assessment about 7 days later to see how the field responded and if your initial assessment was on target.

Calvin

1. Observations from northwest South Plains, May 1

The samples brought to us at the Hale Co. meeting looked 'fairly good' but there were many dead growing points, and there were few tillers left to provide any added level of compensation. The meeting in Hart was similar; several samples there were in the 60+% range of dead growing points, and some with and without the later tillers to make up the difference. Some of the wheat was at late boot, but most still not that far along. Some growers were complaining that their wheat just doesn't seem to be growing any more. Field checks around Halfway showed about 60+% to less than 20% loss (the latter a field of Longhorn, a late maturity variety, for seed).

Texas A&M AgriLife wheat variety trial, Hale Co., FM 788, 2.5 miles west of I-27: This 40-entry variety trial 7 miles NNW of Plainview ranged from mid-boot to heading on May 1. The later maturity varieties have the best shot at surviving the night of May 3 which dropped to near 27°F and appears to have been below 30°F for several hours. It was to our advantage that May 2 was cold (high about 46°F though sunny by mid-afternoon) as this would have kept additional heads from emerging from the boot if it were 60 or 65°F. This field was beautiful on Monday, April 22, in early boot on some varieties, in advance of the April 24 freeze. I saw no dead recent emerging leaves, and only split a few stems, but no dead growing points. I rated all varieties for growth stage on May 1. TAM 111, a medium maturity variety, was "late boot". An assessment of six clumps of wheat collected from TAM 111 plots:

- 92 total stems
- 16 had a dead emerging leaf (it appears that some of these were killed before April 24)
- Of the remaining 76 stems
    - 66 were good (72% overall)
    - 10 had a dead growing point down in the stem that was not otherwise visible

This wheat variety at this site on May 1 looked very good overall and was going to yield well, possibly 50 bu/A plus. It was planted in early November, and has been adequately watered. Now we will see how the May 3 freeze affects it. Being in late boot there is less protection of the head from the canopy.

2. Example of how I assessed a Crosby Co. sample May 2

A wheat sample cut from Crosby Co. was brought to the Center for assessment: from the clumps of plants we counted 39 stems total, of which for 5 stems the most recently emerged leaf was dead. This means no head development, no further stem or forage growth, and these stems are now smaller than the larger ones that continued growth, no need to cut the stem to find the head; (example in Figure 1). Of 34 stems, 21 had sound, viable heads, ranging in size from just starting to emerge, to about 1" length. The 13 dead heads were pale, white, limp, or often had white spikelets on a green rachilla (Figures 1 & 2, the stem portion up through the center of the head). I think the 5 dead stems with the dead emerging leaf likely died in the April 10 freeze; these 13 dead heads that were in stems we cut open most likely died in the April 19 or April 24 freezes. In essence, we have about 60% of the heads still viable, and fortunately since several of these heads are on the cusp of emerging, it is good that was a cold day May 2 in advance of the freeze May 3, to keep them from emerging today (if it were >60 or 65 F) and thus being more susceptible to cold temperatures tomorrow morning.

Figure 1

Figure 2

Figures 1 & 2. May 1, Hale Co., TX. The growing head in top picture has been damaged by freeze though the head is still green. But the developing spikelets are now white, and appear likely to have been injured and won't develop further. In Figure 2, the bottom spikelet is more severely damaged, and awns have not formed nor have the spikelets developed much even though the stem (rachilla) of the head has formed. There is obvious tip damage (white) on the top of the head (right end).

I see no reason to change the management of this field based on the sample that was brought in. Due to overnight temperatures May 2-3 the field will merit an assessment in about 6-7 days to see if heads have withstood the freeze. In a situation like this it might be good to mark plants in the field that are partially/fully emerged before another freeze event, and compare the head status of these with later emerging heads.

If this field were hayed (and the farmer noted that it is on slightly bedded rows, so not conducive to optimum hay harvest) you would want it cut now or very quickly as bearded heads are beginning to emerge. The unspoken downside of haying is that there is nutrient removal (primarily N) in the forage that we are not thinking about what it would cost to replace. (See #8 below.)

And what is the value of the stubble for protection of 2014 seedling cotton, as long as you keep the weeds down and don't have to till?

Follow-up sampling: Any further assessment of the field, to follow-up on the plants we examined, would be to look at perhaps an additional two areas of the field, take a couple of clumps, count 100 stems at each site, divide into green vs. dead emerged leaf, then cut the green stems to see the % of viable heads. There was a minimal ability of these plants to compensate for further yield (losses) due to both a) low number of young tillers remaining to grow and become productive, and b) it is getting late for these tillers to produce much. The plants I believe have already done some of their compensation work, making up some, perhaps, for the 13% of tillers that appear to have died in the April 10 freeze (5 stems of 39).

3. A strategy for assessing wheat samples

Here are some considerations for ongoing assessment of fields. Keep a tally of the different categories of stems you determine, then you can calculate percentages of viable stems for grain production. The stage of growth is much different now than when we first started assessing freeze injury after the March 25 freeze in the Texas South Plains. The numbers of stems or head that fall into the following categories will be used to calculate the percent good growing points an/or the percent good growing points + good heads in the formulas below.

- Are there plants that are headed out? If so divide these up…
    - A: Heads that have visible freeze injury damage (water soaked look, dark green color; sometimes pale green; all or most of the head is white either as it is emerging or after it is headed out, often white on the tip or perhaps the top half of the head)
    - B: Heads that have no visible sign of injury—depending on stage of growth, will need to assess differently: if it doesn't look like it has flowered, then check the florets for viable anthers, etc.; if it appears to have flowered, then we check to see if any grain has developed yet (should be visible within about 3 days of

flowering; see note in #4 below; Figure ___); ensure that these heads are on a stem that is not totally collapsed, but appears to be able to support further growth and development of grain)

- C: Stems that have a dead emerging leaf
- Stems that appear green and healthy (most recently emerged leaf is green)—divide these up…
    - D: Stems that have a dead growing point/dead head
    - E: Stems that have a viable growing point/head is alive; again, and probably even more so than the headed out, viable heads noted above, check the integrity of the lower stem for if you find that a stem looks 'totaled,' e.g. worse than just a mild collapse of the stem, they you should move this stem into the previous category in that it demonstrates low potential to develop a viable, grain yielding head
- F: The presence of smaller tillers on the plant that still might be able to compensate for yield potential, though this potential decreases later in the season (some in your judgment will simply be too small, just too far down in the canopy)

So then you have numbers you calculate such as:

$$\% \text{ good growing points} = E / (D + C + E) \times 100$$

---- OR ----

$$\% \text{ good growing points + heads, thus} = (B + E) / (B + E + A + C + E) \times 100$$

Perhaps you could factor in younger tillers that appear to be able to come on, or let that be qualitative knowledge that we have 58% good growing points but an apparent number of smaller tillers that might now also grow sufficiently to contribute to grain yield.

4. Some of the finer points of wheat freeze injury assessment

The following arises from a discussion with Kansas State's Dr. Jim Shroyer and Steve Watson, from a KSU wheat news release April 27. These should help us understand some finer points of assessing wheat freeze injury.

A) A KSU statement: "If the tillers were in the jointing to pre-boot stage or earlier at the time of the freeze and the tillers are green and growing actively now, then the heads should be fine. If the head had been killed, the tiller would not be green (no! - see Trostle note below) and actively growing. If the leaves coming out of the whorl are chlorotic, then the head on that tiller is dead."

This general topic has been the source of no small amount of confusion among Texas High Plains wheat growers, etc. First, if the growing point is dead,

- of course, there is no (further) development of the head
- but ALSO the most recently emerging leaf, the majority of the time, is NOT dead, at least not for quite a while

- and on that stem there is no further forage growth and stem elongation stops.

I have cut far more stems that had a dead growing point (dead head) but the most recently emerging leaf was very much alive (vs. dead growing point and dead most recently emerged leaf).

But the questions still come. Growers ask: "Will the forage on that stem will continue to increase?" No. "Will the dead growing point be pushed out of the stem?" No. These stems with dead growing point (but green emerged leaf) will remain green for at least 2 and I think even 3 weeks, during which at some point that most recently emerged leaf may start to show signs of dying. In the above statement from the news article it says 'if the head has been killed, the tiller would not be green…' Producers, etc. would potentially then interpret that as, conversely, if the tiller is green the growing point is not dead. I cut some stems May 2 that had a dead growing point, but my best guess is it was killed in the April 10 freeze, but the last leaf is still green three weeks later.

A complicating factor of the above is that some people (and I have been, too) get confounded in that we look at a plant and it appears that less mature stems are dead—as evidenced by a the most recently emerged leaf is dead--whereas other (usually most other) stems are at more advanced stages of growth and are not dead. What? 'How can this be?' one might ask. What I am pretty sure describes most of this scenario is that those stems that are smaller were killed 2 and 3 weeks ago at the growing point. So they have stopped growing, but younger (then) tillers or joints have continued growing and have surpassed the stems that stopped growing due to dead growing point. These younger tillers at the time of freeze injury are now at a more advanced stage of growth and this continued growth has resulted in an actively growing stem that is now 50% and even taller (Figures 3 & 4). The series of pictures in Figures 5 to 7 demonstrates how plants that have stopped growing in a small spot in the field may appear relative to healthier, growing plants.

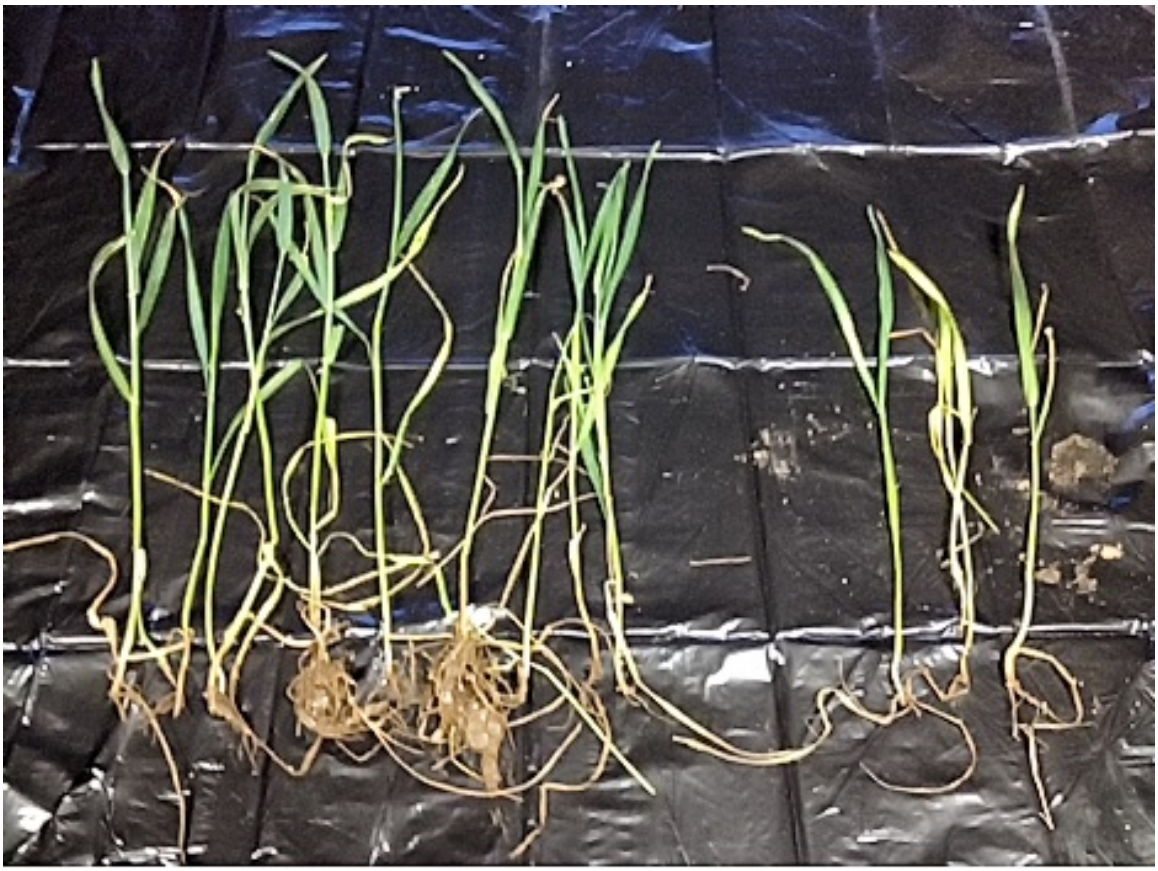

Figure 3. May 2, Crosby Co., TX. A clump of plants was separated into those that appeared normal (left; 1 of 10 stems had a dead growing point) and those where the most recently emerged leaf is visibly dead (right). Stems on the right, which now appear at a less developed stage of growth, stopped growing up to two weeks ago (April 19 or 24 freeze?), and have been surpassed in growth by then undamaged stems/growing points on the left.

Figure 4. May 2, Lubbock Co., TX. Note one small stem (right) that died some time ago, perhaps the April 10 freeze. Other stems continued to grow although one additional stem growing point has died based on visual inspection.

Figures 5, 6 & 7. May 1, Hale Co., TX. Series of pictures showing spotty freeze injury visible on foliage, which contained a high number of dead stems. Aphid damage was high early in these spots. Healthier plants have continued growth and are not taller than damage plants, which are not growing any more. (For reference, note same yellow leaf tip in Figs. 6 & 7.)

4. Finer Points" continued…

B) Another statement in the Kansas State Univ. article reminds me of something I run into from time to time, and I certainly saw it May 1 in the pair of wheat freeze injury clinics and in sample analyses on May 2: <u>just because some anthers may never extrude out of the floret in the spikelet does not mean that pollination failed to occur</u>. It sometimes does. We showed growers, Extension colleagues, and industry several examples where the anthers remained inside the floret, were tan in color (dead), but there was a developing seed now readily evident in the floret (Figure 8). So that is good news. I don't know if there are physiological stress reasons (like those related to drought or freeze) that preclude some anthers from extruding, but I do see this fairly often. Before the embryo starts to swell after pollination it is not always easy to see and should itself not be mistaken for a fertilized seed (Fig. 9). The presence of anthers remaining inside the head after pollination can be frequent (Fig. 10.)

Figure 8. May 2, 2013, Lubbock, TX. This seed's anther is now fading from yellow to tan (dead), and it never extruded from the floret. But clearly the female flower was pollinated as a resulting seed is developing on the right (estimating ~ 4 days or perhaps 5 days after pollination).

Figure 9. May 2, 2012, Lubbock, TX. Small embryo with wisp of feathery female flower on the right that receives available pollen. Anthers are still green (just above embryo), and may be 1-2 days from shedding pollen, and once fertilization occurs should demonstrate swelling within 2 days indicating seed is now growing.

Figure 10. May 1, 2012, Lubbock, TX. Developing seeds from florets have been removed from two heads. These anthers (actually more tan now than yellow) remained inside the florets with these developing seeds. Light quality is poor as the seeds are actually gray-green. The fissure or seam in the developing seed is readily seen on all seeds (a few turned so you can see it). Look for plump developing kernels as evidence kernels themselves have not been freeze damaged (vs. shriveled kernels).

5. Panhandle/Etter research station and area observations from Texas A&M AgriLife –Amarillo wheat breeding crew (April 29, 2013)

Dr. Jackie Rudd (jcrudd@ag.tamu.edu, 806-677-5600) and Moore & Sherman Co. ag. Extension agents Marcel Fischbacher & Brad Easterling met at Etter 8 miles north of Dumas on Monday, April 29, to check out the freeze damage.

"As you know, there was another hard freeze last Wednesday morning, April 24 (and now May 2-3). It has been only 5 days, but I think we were able to make an accurate assessment. All water levels under the pivot were fully jointed and had 2 or 3 nodes on most tillers. The irrigated trials under the linear irrigation system were planted earlier and most varieties are in early boot. There was some variation for foliage burn, but most of the heads were dead in most places we checked. There are some young tillers that might be less damaged, but there is likely not enough cool weather left for these to finish. The damage was similar for all water levels. There may be some variation in varieties, but not much. Brad and I went to another site near Sunray and then I went to a site near Dalhart. Both dryland and irrigated wheat at both locations were similar to what we saw at Etter. I also went to Bushland April 29 and the wheat there is a little better, but still well over 50% loss. Each of the first 3 freezes took their toll, but last week was the most damaging." (Jackie Rudd)

6. Some favorable reports suggesting that some of the wheat crop is not as bad as it seems and may still hold some pleasant surprises (through May 2, prior to May 3 freeze)

In contrast to some of the discouragement you know of in this year's wheat crop, note carefully what these four following individuals are reporting. I know each of these people, and I respect their knowledge and ability to accurately assess wheat freeze injury and its implications.

Kerry Siders (IPM Extension agent, Hockley-Cochran Cos., 806-894-3150, ksiders@ag.tamu.edu) has noted that he has seen several fields in his area that have surprised him with the relatively good condition they are in. In fact as of Wednesday, May 2, he felt there are some fields that still have 40 bushel/acre yield potential, and several others that will still yield well in spite of the growing conditions. Kerry is disappointed that some wheat was cut for hay when it should not have been and has observed that not all the advice that has been given on the decision making of yield potential vs. forage has been reliable.

Olan Moore, High Plains Agricultural Crop Consultants member, covering Lamb-Castro-Swisher counties: After assessments on April 30th, he believes freeze damage to wheat in his customers fields ranged from 13% to 58%. "Every field looked much better than we expected, and grain would sure be a better option that hay/silage right now." However, Olan noted that yield estimates will be much more accurate after wheat heads out (fields are in boot stage right now).

James Todd, High Plains Agricultural Crop Consultants member, covering Hale-Lamb Cos. has noted several fields that were better than expected. Fields that were maintained with irrigation since the freezes started on March 25 are in much better shape.

Andy Watley, Watley Seed Co., Spearman, TX reports May 1 that many of their seed production fields are in somewhat better to good condition versus what they expected. Andy has had to work extra to convince growers to keep the water going, take to grain, as some producers seem perhaps overly willing to pull the plug and go to forage.

With the above comments, this is all the more reason that we must evaluate fields on a case-by-case basis. I have a colleague that was on the radio last week basically implying we needed to mow all the wheat down and go to forage. Whoa! That is a blanket statement, and it is wrong.

7. Implications for seedblock production

I hear that seed companies are in touch with their growers. One company commented to me that they will be sure to "do our growers right" to keep even low-yielding fields going to grain. We already understand that there could be significant potential reduced seed supplies and higher prices for 2013 seed, especially for certified. Texas Department of Agriculture, the certifying agent for seed in Texas, is now inquiring about the prospects of the 2013 seed crop. Also, we do

not yet know if Kansas' seed wheat crop will come through largely unscathed, or if there will be losses there as well. Though I am neutral about this practice, some farmers might now elect to keep some seed to plant their own fields this fall. Seed block growers should be in touch with their contractors if you have not heard from them.

8. Something we haven't talked about—the removal of N and other nutrients if wheat is hayed or put to silage (those nutrients cost significant dollars to replace)

One factor that I have not brought into the discussion over the past couple of weeks on wheat going to forage: the removal of nutrients, primarily N, if growers hay or ensile the crop. We have a lot of "Accidental Forage Growers" in 2013. Much of this wheat is already going to hay or wheatlage. Much of what I looked at May 1 in Hale & Castro counties, due to growth stage, I estimate is probably about 15% crude protein in the mid- to late boot stage. So for each ton per acre dry matter removed (if silage, then figure roughly 3 tons/A of silage = 1 ton/A dry matter, especially if dehydrated a bit by swathing, before ensiling) there'd be:

2,000 lbs./A dry matter X 0.15 (% crude protein) / 6.25 units of protein per unit of N

= 48 lbs. of N per acre removed from the field

32-0-0 N-P2O5-K2O fertilizer (more simply N-P-K) recently priced at ~$420/ton, or $0.656/lb. or unit of actual N fertilizer. If a farmer had to replace the value of the N that is removed, then the N fertilizer itself = $31.50/acre per ton for hay (assumptions: %CP for boot stage wheat, and it might be higher, but we know it decreases steadily with maturity; might be 12-13% for fully headed wheat hay; 11% CP then less as it moves through grain development stages to increasing maturity, bottoming at <9% CP). This potential fertilizer replacement cost does not include application costs (minor if applied through a pivot). Note that the N that would be retained on a field in the biomass of course is not 100% available in the next year. But its removal from the system is usually not recognized or accounted for. Also, as a guideline I figure the value of P, K, S, and micronutrients (but not calcium) removed in the hay is about 1/3 of the value of the N if it had to be replaced.

In contrast, I estimate roughly that the amount of N removed in the grain is about 1/3 to 2/5 of the amount of N removed in hay (assumption: 16 bu/A of grain production to equate with 1 ton/A of dry matter—this is truly an estimate).

So the income from hay removal for our Accidental Forage Growers is not completely "free." Regular forage growers are far more likely to understand this. Yes, it is possible that hay and wheatlage prices are sometimes too low to justify this level of nutrient removal from the field.

And what is the value to many growers, especially cotton farmers in the South Plains, of leaving the wheat for grain (even if yields are low) and managing the stubble for 2014 seedling cotton protection?

9. Failed wheat and crop insurance

A lot of farmers are confused by, or hear differing opinions about, what they can and cannot do if they believe their wheat will make poor grain yields and does not justify grain production. Dr. Clark Neely, State Small Grains Extension Specialist, College Station (979-862-1412, cneely@ag.tamu.edu) notes from the May 1 meeting in Hart that insurance adjusters weren't going to change their minds about making producers wait and see on their fields even if they are certain it's a failed crop. The main reason is that the underwriting of wheat crop insurance policies requires the assessment be made on headed out wheat. It is likely up to individual producers and their crop insurance provider on agreeing whether they maintain strips in the field. But if it is irrigated wheat wouldn't you have to continue watering? It seems like irrigating a long narrow wedge, thus irrigating perhaps only 0.5 to 1.0 acre, would satisfy this requirement better than strips through a field.

10. Have well-watered, well maintained fields survived better with less freeze damage?

I have heard thoughts on this that are all over the board. Let's separate this questions into segments based on season-long management vs. incidental irrigation at or just before a freeze.

- Case 1: Fields that have been well maintained season-long in the face of the drought were likely more advanced in growth stage at the time of the multiple damaging freezes that began March 25. The advanced growth stage relative to wheat that was struggling some (perhaps due to limited or especially minimal irrigation) was thus more susceptible to freeze injury, however, these better-maintained fields may also had more canopy protection. So this is potentially a mixed answer. Figure 11 demonstrates irrigation strips from bubblers on 80-inch rows where wheat was further along and likely damaged more.
- Case 2: Fields that were watered within 1-3 days of a freeze have often been reported as having more foliar damage than those that were not. Lush foliage is more susceptible than foliage that is experiencing some moisture deficit or moisture stress. So that may explain more foliage burn on the top of the canopy. Though some have asserted that they felt their most recently irrigated fields were hurt worse (was this a field that fits Case 1?), we believe that fields with more temperature buffering capacity down in the canopy from either canopy protection and/or soil moisture in the soil surface helped buffer the temperatures experienced at the critical growing point. This could be 2 to 5°F higher in the canopy versus the weather station air temperatures that are recorded at 1 or 2 meters

above the ground. I thank Olan Moore for sharing his soil and canopy temperature sensor data (Lamb and Castro Counties) which demonstrates this.

- Case 3: Fields that have been well watered since the initial freezes hit in late March. Kerry Siders, Hockley-Cochran Co. IPM Extension agent notes in his description of better-than-expected fields (see #6) that producers who stayed with the irrigation to maintain modest to good soil moisture status had, in his opinion, clearly better fields. Though we have had repeated freezes, if we had only 1 or 2 damaging freezes (through May 1) rather than 3 or 4, Kerry believes these producer would have been clear winners at grain harvest time—and still might be.

Figure 11. May 1, 2013, Hale Co., TX. Evident foliar damage on top includes a much more frequent stems that are dead. We believe these strips received more water from drop nozzles/ bubbler irrigation, and were at a more advanced stage of growth thus more susceptible to freeze damage.

11. Bottom Line: Fields must still be evaluated on a case-by-case basis for freeze damage

There is no substitute for assessing a field. Yes, for many fields we now know or will soon know that they are not worth carrying to grain. And how much grain is "worth it" if we have to keep irrigating: 15 or 20 or 25 or 30 bushels per acre? Less if it is a seed block? (Yes.) What are hay prices? Who pays for haying? What are silage prices? If silage price includes a % Crude Protein criterion, will price be discounted heavily if % CP is not met? What are your payment terms and timing? Do you have assurance of timely payment (maybe you offer a discount if you are paid cash at the field)? Be sure to factor in nutrient removal costs if going to forage (an Extension budget worksheet won't include that consideration).

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Editor

Patrick Porter

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Contributing Authors

Calvin Trostle, Extension Agronomist

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