January 2012
URL: http http://www.kingcorn.org/news/timeless/ExtremeCornMgmt.pdf

Corn Management for Extreme Conditions[1]

RL (Bob) Nielsen, Extension Corn Specialist
Agronomy Department, Purdue University
West Lafayette, IN 47907
Email: rnielsen@purdue.edu

Background

Extreme weather events and their effects on crop production certainly seem to be more prevalent in recent years. During the recent 2011 growing season, Indiana crops experienced the stresses of excessively wet conditions early in the season which were followed by unusually warm and dry conditions in the latter half of the growing season. Mixed in with the extremes in rainfall and temperature were an unusual number of individual storms with damaging winds and/or hail that caused extensive and widespread crop damage during the middle of the summer.

The inability to accurately forecast the weather in general, let alone forecast the occurrence or severity of extreme weather events, certainly increases the challenge of consistently obtaining high crop yields and adds to the frustration level of most farmers. In fact, many lament about the fact that we have not had a "normal" growing season for some time.

What is a "normal" growing season? Many of us have a nostalgic memory of growing seasons where the crops emerged quickly, grew vigorously and uniformly, pollinated successfully, filled out grain completely, and stood strong until harvested in the warm, sunny days of early fall. That nostalgia suggests that a "normal" growing season is one without the occurrence of any serious stress to the crop.

Take a look at historical corn grain yields over the past 60 years from throughout the U.S. Midwest. In particular, take a look at the departures from trend yield over that time period (Fig. 1) and then tell me whether we have experienced very many "normal" growing seasons. The bottom line is that year-to-year variability in average statewide corn grain yield has been fairly dramatic since 1950 and commonly ranges plus/minus 10% or greater from trend every year. For individual fields, the variability year to year is often more dramatic.

I would suggest to you that maybe we have all been delusional with our nostalgia and that perhaps a more accurate definition of a "normal" growing season is one that involves an unpredictable number of unpredictable extreme weather events, each occurring unpredictably, with unpredictable severity. The possible difference today versus 60 years

[1] Also available in HTML format on the Web at http://www.kingcorn.org/news/timeless/ExtremeCornMgmt.html

ago is that the frequency of truly extreme weather events may indeed be greater today. How many "storms of the century" can you experience before they are no longer "storms of the century"?

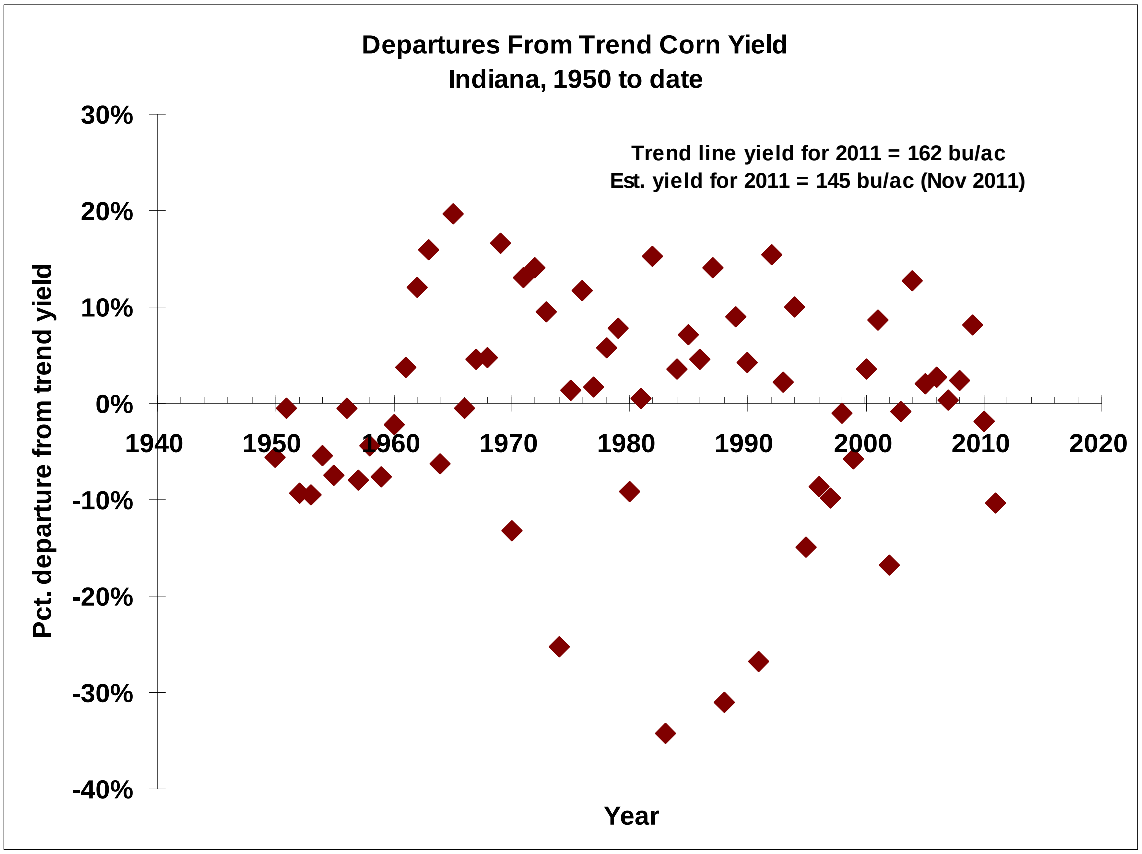

Fig. 1. Percent departure from trend yield for Indiana corn production since 1950. Source of yield data: USDA-NASS.

Let's stress-proof our crops

The effects of weather stress on crop growth are usually compounded by the presence of other yield-limiting factors. Identifying and managing other yield-limiting factors will help you "stress-proof" your cropping system. It is fair to say that we probably cannot manage our crops agronomically to the extent that we can literally stress-proof them against the vagaries of Mother Nature. However, it is well worth the effort to manage important yield-limiting factors as best as we can to at least improve the tolerance of our crops to the effects of extreme weather events.

Yield influencing factors (YIFs)

The process of identifying the YIFs that are important to your specific fields is not an easy one. First of all, these YIFs can be either negative or positive in their effects on yield. Pay attention to both.

These YIFs may occur every year in a given field…….. or they may not.

These YIFs often interact with other YIFs to influence yield. Think about the compounded effects of heat + drought + soil compaction.

These YIFs often affect different crops differently. For example, most of us do not worry about gray leaf spot disease in soybeans. Frankly, as a corn guy, I don't worry about soybeans anyway, but that's another story.

These YIFs often interact with soil type / texture / drainage conditions.

These YIFs almost always interact with weather conditions.

Ultimately, the effects of YIFs on corn yield are equal to their effects on the four components that constitute grain yield. The timing of the occurrence of YIFs relative to crop growth stage greatly determines their effect on these yield components because they develop at different times throughout the season (Fig. 2).

- Plants per acre (population or "stand")
- Ears per plant (degree of barrenness)
- Kernels per ear (potential vs. actual)
    - Kernel rows per ear
    - Kernels per row
- Weight per kernel

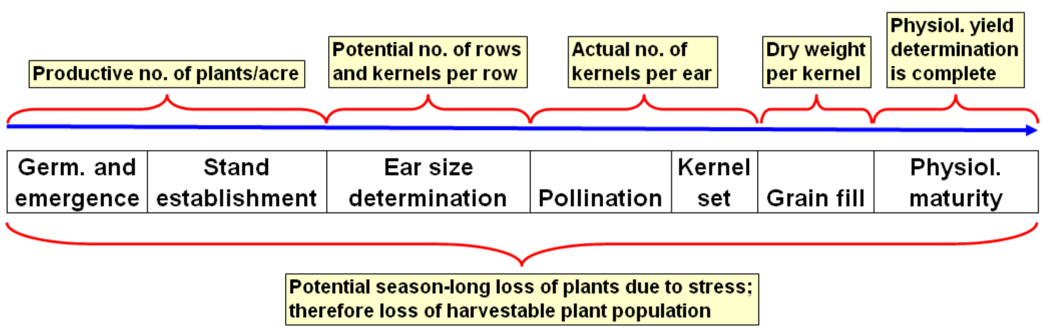

Fig. 2. Phenological timeline of the development of yield components in corn.
(Source: Nielsen's imagination)

Once you sit down to list the possible YIFs that may influence corn yields on your farm, you will easily reach the conclusion that there must be a gazillion YIFs to consider. Where do you begin?

If you have farmed a particular field for a while, your own experience in that field is invaluable to identifying the YIFs specific to that field. You can probably come up with a short list of obvious YIFs based on that alone.

In future cropping seasons, strive to keep thorough notes on what happens with the crop during the entire growing season. Don't just plant it and come back at harvest. Visit your fields regularly. Sure, you can hire a crop scout to walk your fields for you, but there is a lot to be said for you walking your fields yourself.

Take advantage of the agronomic skills and knowledge of both the private and public sectors. Work closely with the sales or technical agronomists from your crop input retailers. Consider hiring the services of an independent crop consultant.

Don't forget the Extension resources available at your own land-grant university. You say you don't know the name of your state's Extension corn or soybean agronomist? Shame on you! You can find them in the following Web directories. These specialists can also put you in contact with other, more specific, content matter specialists at your land-grant university.

http://www.kingcorn.org/experts/CornSpec.html

http://www.kingcorn.org/experts/soyspec.html

Stay up to date during the growing season by reading Extension newsletters from around the Midwest. You can find most of them linked at my Chat 'n Chew Café Web site: http://www.kingcorn.org/cafe. Yes, I know this is shameless promotion of my own Web activity, but what can I say?

Spend time perusing university Web sites that focus on corn production issues.

Mine at Purdue: http://www.kingcorn.org/news/archive.html

Jeff Coulter's at Univ Minnesota: http://www.extension.umn.edu/corn

Roger Elmore's at Iowa State Univ: http://www.agronext.iastate.edu/corn

Did your wife buy you a Smartphone or tablet for your birthday with 3G cellular connectivity? Install a GIS app on it and use the thing to map problem areas in the field for future reference. I have used an app called GISRoam with my Apple iPad to map problem areas or field features with reasonably good success. There's another app called iGIS that I have not used enough to comment on, but it's worth checking out. If you use your iPhone, I would recommend considering an after-market phone case that contains an additional battery to provide you with more hours of GIS field scouting.

Take advantage of previous year's yield maps to physically direct you to specific spots in a field to continue your hunt for YIFs. Target those field areas for specific soil sampling. Target those areas to intentionally scout the following crop season.

Do you have access to aerial imagery during the growing season? Recognize that aerial imagery by itself often cannot identify the cause of visual differences in a field. That is usually your job using the imagery to guide you to spots in the field.

The bottom line with this discussion is…….. Get out into your fields during the growing season, identify problem areas early while the evidence is still there to aid diagnostics, and figure out what's going on with your crops!

Key factors to consider

Improving crop tolerance to weather stress is strongly dependent on establishing a healthy, vigorous stand of corn by the time the crop has reached ~ V6 (knee-high). Crop tolerance to weather stress also relies on maintaining the health of the root system and crop canopy throughout the season. Many factors influence the growth and development of a corn crop. The following are some of the ones I believe to be important for Indiana corn production. If you do not farm in Indiana or the eastern Corn Belt, filter my comments with the experiences you have with your own farming operation.

Field drainage

In my area of the eastern Corn Belt, naturally poorly-drained soils constitute a major perennial challenge to establishing vigorous stands of corn by virtue of their effects on the success and uniformity of rooting and plant development. The adequacy of field drainage (tile or surface) greatly influences whether corn will produce 200-plus yields or nothing (ponded out) or somewhere in between.

By improving tile or surface drainage in a field, you can reduce the risks of ponding or soggy soils, loss of soil nitrate by denitrification, and soil compaction by tillage and other field equipment. Reducing these risks enables more successful root development and stand establishment of the corn crop, which in turn will enable the crop to better tolerate stresses later in the growing season.

Soil erosion control & soil moisture conservation

In other areas of Indiana or the Midwest, the challenge may not be related to flat poorly drained soils, but rather to rolling topography with high risks of soil erosion and lower ability to retain soil moisture during the growing season. In these areas, better management practices are those that concentrate on minimizing water runoff and maximizing soil moisture retention.

- No-till or reduced tillage
- Terraces & other water control structures
- Fall / winter cover crops

Supplemental water

Some soils in the eastern Corn Belt suffer from the opposite problem of drying out too easily when rainfall is inadequate or simply do not have adequate soil moisture holding capacities. Obviously, fields with those soils will usually respond to supplemental water provided by above-ground irrigation (center pivots, shotguns, row irrigation) or below-ground supplementation by virtue of pumping water back into tile drains or drainage ditches. Either choice requires informed decision-making relative to irrigation scheduling based on crop demand and soil water availability (Joern & Hess, 2010). Maintenance and proper operation of center pivot irrigation systems is crucial to optimize efficiency in terms of irrigation costs and crop benefit.

Hybrid selection

Most of us spend too little time evaluating the documented performance of potential hybrids for use in our operations. Look at any hybrid trial that includes “good” hybrids from a range of seed companies and you will easily see a 50 to100 bushel range in yield between the top and bottom of the trial. Mind you, this spread from high to low occurs in variety trials where supposedly every hybrid entered into the trial is a “good” hybrid. I doubt that seed companies enter “bad” hybrids on purpose.

The key challenge is to identify hybrids that not only have good yield potential, but that also tolerate a wide range of growing conditions (Nielsen, 2010). The best way to accomplish this is to evaluate hybrid performance across a lot of locations. University trials are good for this exercise (Iowa State Univ, 2011; Devillez, 2011; Univ of

Minnesota, 2011). If you use seed company trials, be aware that often there are few competitor hybrids included in variety trial results.

Recognize that no hybrid wins every trial in which it is entered. Look for hybrids that consistently yield no less than about 90% of the highest yield in the trial no matter where they are grown. For example, if the top hybrid in a particular trial yielded 230 bpa, then look for hybrids in the same trial that yield at least 207 bpa (230 x 0.90). That may not sound like much of a challenge, but you will be surprised how few hybrids will meet that goal when evaluated over a lot of locations.

Once you've identified some promising hybrids based on their consistency of performance, then concentrate on other important traits like resistance to important diseases in your area of the state.

Manage trash in no-till

If you no-till corn on soils that are poorly drained, then you simply must strive to manage surface "trash" to enable drying / warming of surface soils, facilitate effective planter operation, and improve crop emergence / stand establishment. Aim to burn-down winter annual weeds or cover crops before their growth becomes unmanageable. Use row-cleaners on the planter units to remove a narrow band of "trash" from the seed furrow area. Avoid planting "on the wet side" in order to minimize the risk of furrow sidewall compaction or topside compaction.

Avoid soil compaction

If you improve soil drainage, you will also minimize the risk of working or planting fields "on the wet side" and, therefore, the risk of creating soil compaction with tillage or other field operations that can limit root development. Minimize the number of tillage trips, consider strip-till or no-till systems. Remember, though, that no-till or strip-till is not immune to the risk of soil compaction.

Continuous corn or not?

Frankly, continuous corn simply does not yield as well as rotation corn. Numerous long-term rotation trials have documented this across a number of states. The yield drag is especially likely for no-till corn after corn. Folks who claim to do well with continuous corn are often fairly aggressive with their management of the stover from the previous crop.

Corn stover delays the drying / warming of the soil and thus delays crop emergence and development. Corn stover (including old root balls) often interferes with planter operation, causing poor / uneven seed depth or seed-2-soil contact and thus causes delayed or uneven crop emergence. Decomposing corn stover immobilizes soil nitrogen early in the season and can retard corn growth and development early in the season until root development reaches a critical mass. Corn stover can intercept soil-applied herbicide and reduce the effectiveness of weed control. Finally, corn stover harbors inoculum of important diseases like gray leaf spot or Goss' wilt.

Any way you look at it, a continuous corn cropping system is fraught with challenges.

Starter fertilizer or not?

Starter fertilizer, especially nitrogen, is important for maximizing corn yields in the eastern Corn Belt. I offer the following explanation and leave it to you to decide whether your situation is similar.

A little background: Young corn plants depend heavily on stored kernel reserves until roughly the V3 stage of development (three leaves with visible leaf collars). At that point, the plants begin to "wean" themselves from dependence on the stored kernel reserves (which are playing out) to dependence on the developing nodal root system. If life up to that point has been hunky-dory, the transition to dependence on the nodal roots will go smoothly and the crop will continue to develop into a vigorous and uniform stand that will tolerate future stresses nicely.

However, if conditions have been challenging during emergence and early stand establishment, then nodal root development has probably been stunted and the young plants will struggle to "wean" themselves from the kernel reserves. Consequently, the plants will appear to "stall out", their development will become uneven, they will turn light green to yellow, and the resulting stand will not be as vigorous and uniform as you want. Such a stand of corn will likely continue to struggle the remainder of the season.

It is the latter situation wherein a robust 2x2 starter fertilizer program will aid the young plants as they struggle in the transition to dependence on nodal roots. Our experience in the eastern Corn Belt suggests that starter nitrogen is the primary important nutrient and starter N rates should be no less than 20 to 30 lbs actual N per acre; perhaps higher than that for no-till continuous corn.

Nitrogen management

Nitrogen management in the eastern Corn Belt is challenging because of our poorly drained soils, ample rainfall, and the risk of N loss by either denitrification or leaching. Consequently, yields are often lower than desired because of inadequate levels of soil N during the growing season, resulting in lower grain income for the grower. Alternatively, growers sometimes apply more N than the crop requires in an effort to mitigate the consequences of excessive N loss on the crop and, thus, incur higher crop production expenses.

Best management practices that target the efficient use of nitrogen fertilizers in corn are well documented (Camberato et al., 2011; Sawyer, 2011) and include avoiding fall N applications, avoiding surface application of urea-based fertilizers without incorporation, and adopting sidedress N application programs where practical. These practices, plus the implementation of a robust starter fertilizer program, will help reduce the loss of soil N and maximize the bushels produced per pound of N fertilizer applied.

Disease management

Warm, humid conditions typical of the eastern Corn Belt during the summer months are conducive for the development of several important foliar fungal corn diseases, including gray leaf spot and northern corn leaf blight. Goss's Wilt, a potentially severe bacterial disease, has "migrated" into Indiana in recent years and represents a new challenge for growers in the eastern Corn Belt. Yield losses from these foliar corn diseases can easily decrease corn grain yields by 20% or more.

Best management practices that target efficient management of these important corn diseases are well documented (Wise; 2010a, 2010b, 2011) and include:

- Hybrid selection for good disease resistance characteristics.
- Avoiding continuous corn cropping systems.
- Avoiding no-till cropping systems.
- Responsible use of foliar fungicides (except for Goss's Wilt)

Remember, it ain't rocket science!

It should be obvious at this point that improving crop tolerance to the stress of extreme weather does not require "rocket science". Rather, we're talking about a lot of common sense agronomic principles that work together to minimize the usual crop stresses that occur every year and allow the crop to better tolerate uncontrollable weather stresses. Other agronomic practices not discussed in this summary include a sound weed control program that focuses on the use of residual herbicides and an attitude that you will aim to kill weeds when they are small.

Make the effort to identify those yield limiting factors that are most important for your specific farming operation. This requires good crop detective skills and a sound understanding of agronomic principles. Together with your crop advisor(s), work toward identifying and implementing good agronomic management practices that target those yield limiting factors.

References

Camberato, Jim, RL (Bob) Nielsen, Eric Miller, and Brad Joern. 2011. Nitrogen Management Guidelines for Indiana. Applied Crop Research Update, Purdue Extension. online at http://www.kingcorn.org/news/timeless/NitrogenMgmt.pdf [URL accessed Oct 2011].

Coulter, Jeff. 2011. Corn Production. Univ. of Minnesota. online at http://www.extension.umn.edu/corn [URL accessed Dec 2011].

Elmore, Roger. 2011. Corn Production. Iowa State Univ. online at http://www.agronext.iastate.edu/corn [URL accessed Dec 2011].

Iowa State Univ. 2011. Iowa Crop Performance Tests. online at http://www.croptesting.iastate.edu [URL accessed Dec 2011].

Joern, Brad and Phil Hess. 2010. Irrigation Scheduler. Purdue Research Foundation. download online at http://www.agry.purdue.edu/irrigation [URL accessed Dec 2011].

Devillez, Phil. 2011. Purdue Crop Performance Program. Purdue Univ., online at http://www.ag.purdue.edu/agry/PCPP/Pages/default.aspx [URL accessed Dec 2011].

NCGA. 2010. Winners Corn Yield Guide. National Corn Growers Association. online at http://www.ncga.com/uploads/useruploads/ncyc2010.pdf [URL accessed Dec 2011].

Nielsen, RL (Bob). 2010. Hybrid Selection: Where's the Beef? Corny News Network, Purdue Univ. online at http://www.agry.purdue.edu/ext/corn/news/timeless/HybridSeln.html [URL accessed Dec 2011].

Nielsen, RL (Bob). 2011. Chat 'n Chew Cafe. Purdue Univ. online at http://www.kingcorn.org/cafe [URL accessed Dec 2011].

Nielsen, RL (Bob). 2011. Corny News Network Archives. Purdue Univ. online at http://www.kingcorn.org/news/archive.html [URL accessed Dec 2011].

Nielsen, RL (Bob). 2011. State Extension Corn Specialists. Purdue Univ. online at http://www.kingcorn.org/experts/CornSpec.html [URL accessed Dec 2011].

Nielsen, RL (Bob). 2011. State Extension Soybean Specialists. Purdue Univ. online at http://www.kingcorn.org/experts/SoySpec.html [URL accessed Dec 2011].

Sawyer, John. 2011. Nitrogen; a sub-section of the Iowa State Univ Soil Fertility Web Site. online at http://www.agronext.iastate.edu/soilfertility/nutrienttopics/nitrogen.html [URL accessed Dec 2011].

Univ of Minnesota. 2011. Corn Grain and Silage Variety Trials. online at http://www.extension.umn.edu/corn/trials.html [URL accessed Dec 2011].

USDA-NASS. 2011. QuickStats. United States Dept Agric – Nat'l Ag Statistics Service. Online at http://quickstats.nass.usda.gov [URL accessed Dec 2011].

Wise, Kiersten. 2010a. Goss's Bacterial Wilt and Leaf Blight. Purdue Extension publication BP-81-W. online at http://www.extension.purdue.edu/extmedia/bp/BP-81-W.pdf [URL accessed Dec 2011].

Wise, Kiersten. 2010b. Gray Leaf Spot. Purdue Extension publication BP-56-W. online at http://www.extension.purdue.edu/extmedia/bp/BP-56-W.pdf [URL accessed Dec 2011].

Wise, Kiersten. 2011. Northern Corn Leaf Blight. Purdue Extension publication BP-84-W. online at http://www.extension.purdue.edu/extmedia/BP/BP-84-W.pdf [URL accessed Dec 2011].