GMO SMACKDOWN: TRAITED VERSUS CONVENTIONAL

Joe Lauer[1]

Buying corn hybrids is more confusing than ever. In the past corn was sold as dent corn and farmers had to worry about performance issues whether it was a single-cross, three-way cross, or double-cross. Then specific markets emerged and waxy, high-oil, brown midrib, leafy and nutrient dense hybrids were marketed. Today we still have many of these hybrids with genes targeted for specific uses. Most of the confusion today about hybrid selection is due to the combinations of available transgenes that protect yield better than ever before.

A farmer told me that his seed company had significantly dropped the price of a SmartStax hybrid to a price point that was similar to an average hybrid. The farmer felt that he got a "good deal." But, was it a good deal? How should we approach hybrid selection decisions involving transgenes? Certainly seed price is a factor. But even an expensive hybrid with many transgenic traits sold cheaply could be even more expensive for that grower if it doesn't yield well.

For years we have recommended to growers to choose hybrids by using comparative yield performance data. We do this by selecting hybrids with high average yield that is consistent across many environments and management situations. In the last few years these two basic principles have expanded to the following five principles:

1) Use multi-location averages to compare hybrids
2) Evaluate consistency of performance
3) Pay attention to seed costs
4) Every hybrid must stand on its own
5) Buy the traits you need

In this paper, I would like to review these principles of hybrid selection and expand on one of them – "Every hybrid must stand on its own." I will use the Mon810 (YieldGard) event as an example, but in the presentation I will include Mon810, TC1507 (Herculex1) and Bt11 (AgrisureCB).

What criteria should you select hybrids for?

In Wisconsin the two major uses of corn are grain and silage. There has been enough breeding progress, especially in corn silage, that the hybrid selection criteria for grain versus silage uses are different. The most important consideration regardless of use is yield. For grain, moisture at harvest can often mean the difference between profit and loss in the northern Corn Belt. For corn silage hybrids, large differences exist for quality parameters such as starch content and NDFD.

Table 1. Criteria for selecting corn grain and silage hybrids.

Criteria for Grain Hybrids	Criteria for Silage Hybrids
Grain yield	Forage yield
Grain moisture	Forage quality (i.e. Starch content, NDFD, and NDF)
Plant lodging	Insect resistance
Insect resistance	Disease resistance
Disease resistance	Plant lodging
Grain quality (i.e. Test weight, kernel breakage susceptibility)	Forage moisture
Other factors	Other factors

[1] Professor, Dept. of Agronomy, Univ. of Wisconsin-Madison, 1575 Linden Dr., Madison, WI 53706.

Use multi-location averages to compare hybrids

Use multi-location information to evaluate grain yield, grain moisture, and standability. Today, most universities compile hybrid yield data over multiple locations. They statistically make these comparisons by testing the same set of hybrids at each location. Begin with trials that are nearest to you. Compare hybrids with similar maturities (harvest grain moisture) usually within about a 2% range in grain moisture. To ensure genetic diversity on your farm, divide the trials into two or three groups based upon grain moisture.

Consider single location results (even if the trial was conducted on your farm) with extreme caution. Use single location information (your own on-farm trial) to evaluate test weight, dry-down rate, grain quality and ease of combine-shelling or picking. The way you approach the hybrid selection decision, e.g. single-location versus multiple-locations, makes all of the difference in subsequent profitability. For more information regarding selection strategies and predicted yield increases see http://corn.agronomy.wisc.edu/AA/A012.aspx. There are many possible sources of comparative yield performance data including strip-trials (seed company and independent) and replicated-trials (F.I.R.S.T. and university). Each source of data has it's own strengths and weaknesses.

Evaluate consistency of performance

Look for hybrids that yield consistently across a diverse set of conditions. Be wary of any hybrids that finish in the bottom half of any trial. Seed companies benefit greatly from all those on-farm trials that farmers participate in (numerous weather patterns and pest situations per year). So if you concentrate on your on farm results (or the local area results), you miss out on the benefits of all the testing that goes on nationally. Corn breeders define hybrids as "stable" when they have a minimum of interaction with environments. Most hybrids are stable, but a few get reputations as "racehorse" or "workhorse" hybrids. These are difficult to characterize because it takes numerous environments to determine.

Pay attention to seed price

A major change in extension recommendations has occurred recently due to corn seed costs that have dramatically increased. It is not unheard of for seed of high-performing premium hybrids with transgenic traits to cost over $250 per bag, whereas 10 years ago, premium seed would cost about $80-$100. It is important to compare the "difference" between any two hybrids. A price that is different by more than $50-$100 per bag must be carefully considered because it is difficult to make up the bag price difference with increased yield. For a further discussion of this principle, please see http://corn.agronomy.wisc.edu/AA/pdfs/A073.pdf. Also a seed cost calculator is available at http://corn.agronomy.wisc.edu/Season/DSS.aspx.

Buy the traits you need

Remember that transgenic "traits do not increase yield, they protect yield." There are pros (safety, efficacy, and insurance discounts) and cons (expense and resistance potential) to using transgenic traits. Wisconsin is fortunate in that our landscape often includes alfalfa and pasture as part of our crop rotations. We can use these crops to help control pest outbreaks and slow development of resistance to transgenic events. Unfortunately up to this time, it was often difficult to buy the specific traits that you need. However, this is changing and in the near future there will be more opportunity to purchase specific traits.

Every hybrid must stand on its own

Every hybrid must "stand on its own" for performance. You don't know what weather conditions (rainfall, temperature) will be like next year. Just because it is transgenic and you pay extra for traits does not mean it will be high performing. Performances of hybrids with transgenic events

vary by year and the combination of events stacked into the hybrid. We see transgenic hybrids ranked at the top and bottom of a hybrid trial. Therefore, the most reliable way to predict hybrid performance next year on your farm is to consider past performance of individual hybrids over a wide range of locations and climatic conditions. We see large difference among hybrids within a family (see Table 5 of http://corn.agronomy.wisc.edu/AA/A060.aspx).

Materials and Methods

For all corn hybrid evaluation trials a descriptor of the trial is the trial average. Trials are often broken into high- and low-yielding environments. All hybrids grown in a trial can be compared to the trial average. For Figures 1-3 and Table 2, I calculated a grain yield difference (bushels/Acre) between the trial average and hybrids with various transgenic technologies. Growers are usually not interested in all hybrids; rather it is the group that ranks near the top of a trial that is of most interest. Therefore, I also calculated the grain yield difference of the Top 20% of the hybrids by recalculating the average of the Top 20% hybrids and subtracting the average of various hybrid transgenic technologies. If the transgenic technology did not finish in the Top 20%, then the top hybrid for that technology was selected as the representative in the Top 20% calculations. The data source was the University of Wisconsin hybrid evaluation trials from 1990 to 2010.

Results and Discussion

Conventional hybrids have been tested in trials every year (Figure 1). The number of conventional hybrid Genotype x Environment (GxE) means in the UW trials has decreased from a maximum of 1963 GxEs during 1995 to 17 GxEs in 2009. In 1992, the first tissue cultured hybrids were tested. In 1996, the first transgenic hybrids were tested.

Beginning about 1999, conventional hybrids yielded less than the trial average. Grain yield of conventional hybrids has steadily decreased compared to the trial average to a low of 11 bu/A below the trial average in 2008. Since then yield of conventional hybrids has improved and in 2010 conventional hybrids were no longer different from the trial average.

For hybrids in the Top 20%, the conventional group yielded above the trial average of the Top 20% from 1998 to 2000. Since 2006, the conventional hybrids in the Top 20% have yielded significantly below the trial average.

Transgenic events have been sold commercially in Wisconsin since 1996. The events are offered for sale by seed companies either singly or in numerous combinations (stacks). As an example, one of the first commercial transgenic events sold to farmers was the Mon810 (YieldGard) event beginning in 1997 (Figure 2). Right from the beginning, hybrids with the Mon810 event yielded above the trial average for all hybrids until 2007. Among the Top 20% group, Mon810 hybrids yielded above the trial average beginning in 2001. The Mon810 event achieved it greatest yield difference from the trial mean in 2002, the last peak year of fall European corn borer larvae numbers (WI DATCP survey). Since 2007, hybrids with the Mon810 event in the Top 20% group have yielded below the trial average.

The Mon810 event has been stacked with other transgenic events (Figure 3) including Roundup Ready 2 (Nk603), YieldGard Plus (Mon863) and the triple stacks - YieldGard Plus RR2 (Mon810+ Mon863+ Nk603) and YieldGard VT Triple (Mon810+ Mon88017+ Nk603). The pattern of the performance of stacked hybrids varies by year and the combination of transgenic events. The YieldGard RR2 stack has done exceptionally well when measured against all hybrids in a trial. In the the Top 20% group, it took nearly 6 years (1999 to 2004) before this stack beat the trial average (2005 to 2007).

Figure 1. Relative performance of conventional corn hybrids compared to the trial average of all hybrids and the Top 20% of the hybrids. Grain yield difference (bu/A) = hybrid average – trial average. Error bars represent the standard error of the mean.

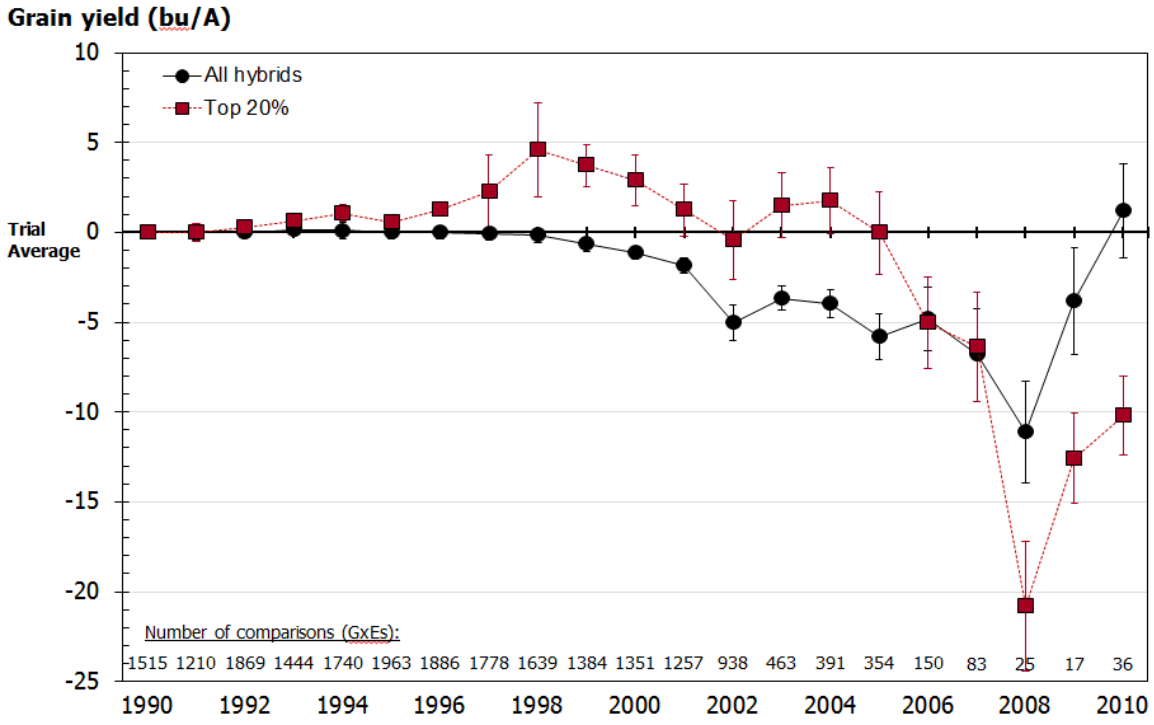
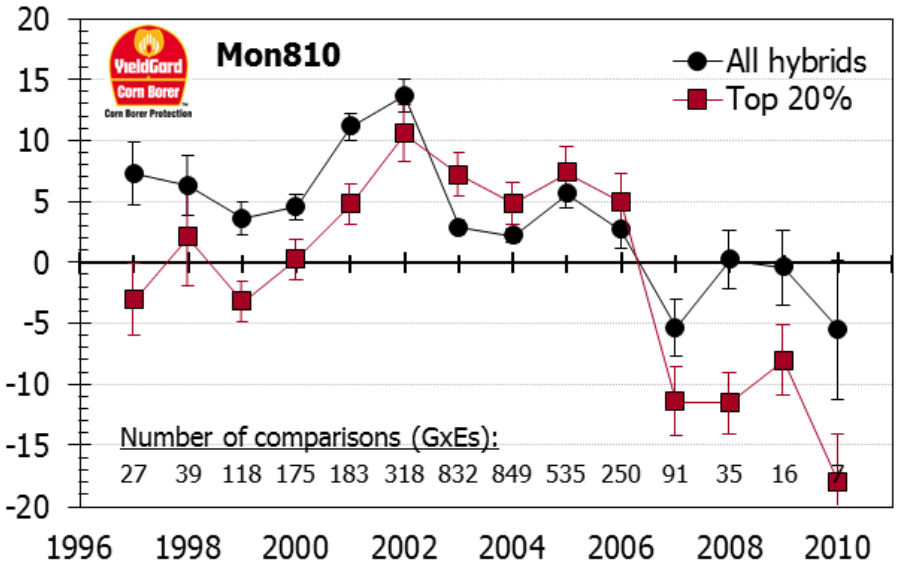


Figure 2. Relative performance of corn hybrids with the Mon810 transgene compared to the trial average of all hybrids and the Top 20% of the hybrids. Grain yield difference (bu/A) = hybrid average – trial average. Error bars represent the standard error of the mean.



The Mon810+Mon863 stack was grown in the UW trials from 2005 to 2008. In 2007 and 2008 this stack yielded at the trial average for all hybrids and only in 2008 for the Top 20% group. The triple stack Mon810+Mon863+Nk603 yielded similar to the trial average in every year of testing between 2005 and 2010 for all hybrids and the Top 20% group. Finally the YieldGard VT Triple technology (Mon810+Mon88017+Nk603) has performed exceptionally well, especially within the Top 20% group.

The performance of the Mon810 transgenic event is typical of most transgenic events. It takes time for the event to be properly incorporated into genetic backgrounds of elite, high performing and adapted hybrids. In 2010, growers were particularly interested in the new SmartStax hybrids containing 8 traits and 34 transgenes. Their performance was average for all hybrids and the Top 20% group (Table 2), and they were average in all Wisconsin production zones.

So is the SmartStax hybrid a "good deal? Not likely, given the price in 2010 and the below average performance against other transgenic combinations. But it also depends on whether the traits were needed for the field the grower intended to plant the hybrid. If a grower doesn't need all of the traits, he probably could have grown another cheaper hybrid and produced more grain yield. Given the track record of other transgenic introductions into the market, the expectation is that SmartStax hybrids will eventually be a high yielding combination of transgenic events – but not just yet.

Figure 3. Relative performance of corn hybrids with the Mon810 event stacked with other events compared to the trial average of all hybrids and the Top 20% of the hybrids. Grain yield difference (bu/A) = hybrid average – trial average. Error bars represent the standard error of the mean.

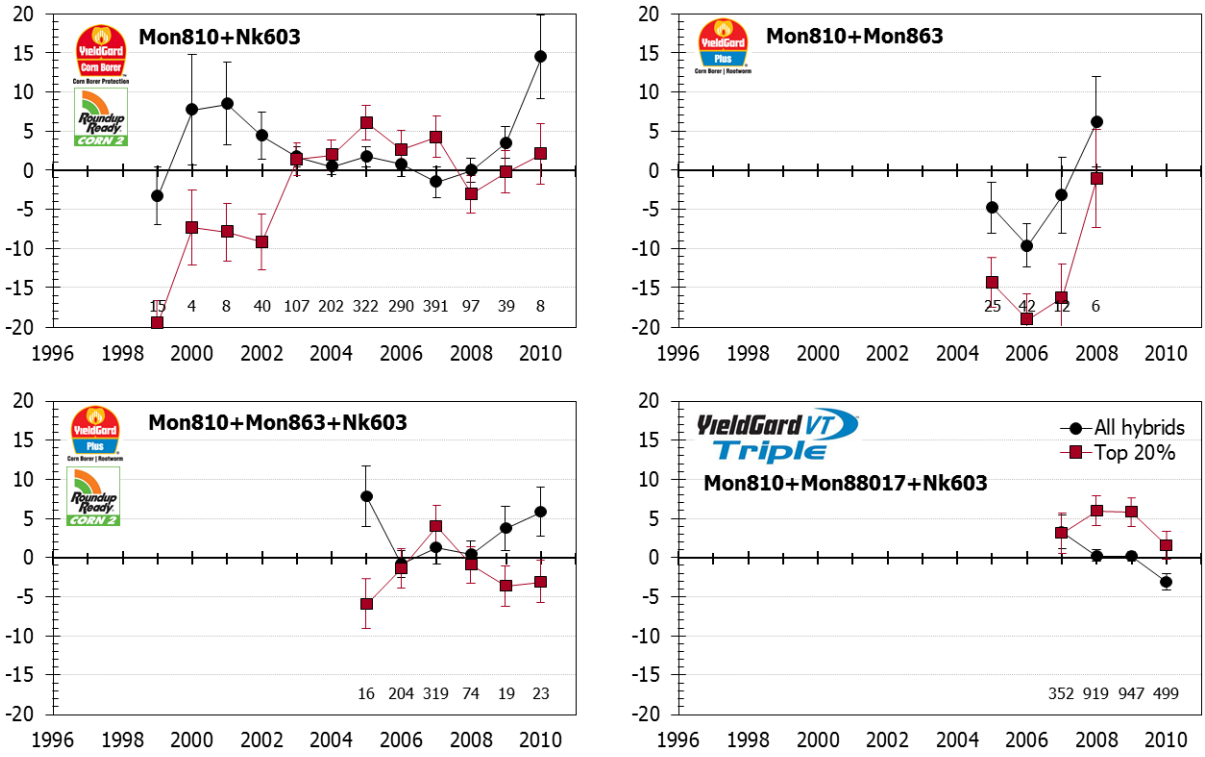


Table 2. Performance of corn transgenic technologies in Wisconsin during 2010. Values are summarized for the Top 20% of hybrids and for all hybrids across Wisconsin and within each production zone.

		Top 20%		All Hybrids					
Technology	Traits: Events	GxE†	Diff.‡	GxE	Diff.	South	South central	North central	North
		N	bu/A	N	---------- bu/A ----------				
	Conventional: None	26	-10.2	36	1.2	-0.8	2.1	-8.3	12.3
	CB: Mon810	7	-18.0	7	-5.4	-14.6	--	1.5	--
	LL: T25	11	-0.9	18	5.4	--	0.1	8.1	--
	RR: GA21	17	-8.6	23	0.8	-0.2	-4.0	7.1	--
	RR: Nk603	42	4.4	118	4.5	-0.3	6.1	9.6	-2.5
Agrisure CB/LL	CB,LL: Bt11+T25	13	-6.3	30	2.7	--	--	2.4	3.1
	CB,RR: Mon810+Nk603	8	1.8	8	14.5	--	--	11.4	17.7
Agrisure CB/LL/RW	CB,CR,LL: Bt11+MIR604+T25	9	-18.4	9	-6.1	-8.9	-0.7	--	--
	CB,CR,RR: Mon810+Mon863+Nk603	17	-3.0	23	5.9	14.3	3.4	6.3	--
YieldGard VT Triple	CB,CR,RR: Mon810+Mon88017+Nk603	107	1.6	499	-3.1	-0.5	-1.1	-4.2	-8.3
VT TRIPLE PRO CORN	CB,CR,RR: Mon89034+Mon88017+Nk603	18	-4.1	53	2.4	4.3	-0.2	3.9	--
Agrisure GT/CB/LL	CB,LL,RR: Bt11+T25+GA21	39	0.1	104	5.0	--	-1.2	3.2	10.0
	CB,LL,RR: TC1507+T25+Nk603	60	5.2	209	1.7	6.9	1.6	-1.0	-2.4
Agrisure 3000GT	CB,CR,LL,RR: Bt11+MIR604+T25+GA21	58	-0.1	248	-1.7	-3.4	1.8	-6.5	3.4
	CB,CR,LL,RR: TC1507+DAS591227+T25+GA21	13	-17.1	20	-6.8	-10.5	-9.8	-1.7	--
	CB,CR,LL,RR: TC1507+ DAS591227+ T25+ Nk603	31	4.5	115	2.4	0.9	1.3	4.3	12.1
SmartStax	CB,CR,LL,RR: TC1507+ Mon89034+ DAS591227+ Mon88017+ T25+ Nk603	33	-2.4	105	-2.2	-1.0	-2.2	-3.8	-2.6
	LSD (0.10)		6.3		6.8	13.0	9.3	9.2	12.0

† GxE: Number of replicated hybrid means used to calculate Diff.
‡ Diff.: Grain yield difference = hybrid average – trial average

Key References

Lauer, J. 2008. Corn Hybrid Selection. Field Crops 28.31-60.

Lauer, J. 2009. Getting a Handle on Corn Seed Costs. Field Crops 28.424 - 73.

Lauer, J., and K. Hudelson. 1997. The University of Wisconsin Corn Hybrid Trials -- Selecting the Top Performers. Field Crops 28.31-12.