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Thoughts on Row Spacing & Plant Population

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KingCorn:
www.kingcorn.org

Chat 'n Chew Café:
www.kingcorn.org/cafe



v20101129 Image source: Library of Congress

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It's all about capturing sunlight!



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Building a crop canopy




- Every agronomic decision you make potentially influences crop canopy development and the capacity to intercept sunlight.
-
- Not to mention the influences of weather, soils, and pests during canopy developmt.

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Bottom line on seeding rates...

- Current data suggest that many growers should be targeting **economic FINAL stands** no less than ~ 30,000 ppa; equal to a seeding rate of ~ 33,000 spa.
- Exceptions being...
 - Lower yielding environments (e.g., 130 bpa or less) where growers should target final populations between ~ 24 to 30,000 ppa.
 - More northern areas where final stands may need to be 33,000 ppa or greater.

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Seeding Rates

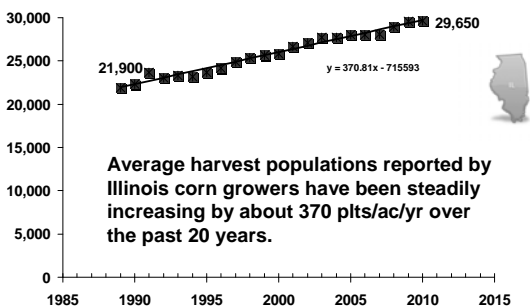
Balancing act for corn...

- More plants per unit area equals more ears per unit area. (that's good)
- But, ear size per plant decreases with increasing plant density. (that's not good)
- The optimum final stand is that which best balances the decrease in ear size per plant with the gain in ears per unit area.
- Furthermore, stalk health & integrity at higher populations sometimes falters.


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Image: <http://scannemondry.files.wordpress.com/2007/07/balancing-act-001.jpg>

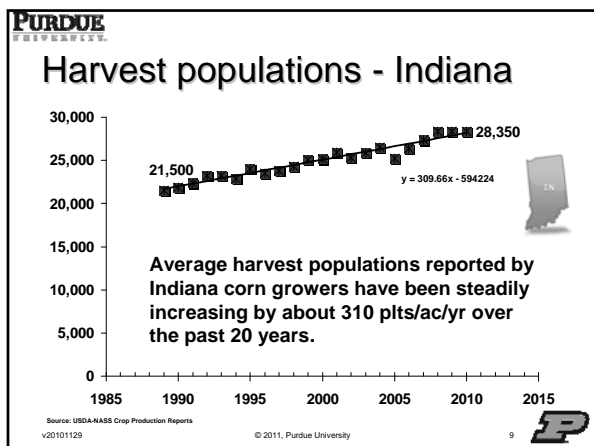
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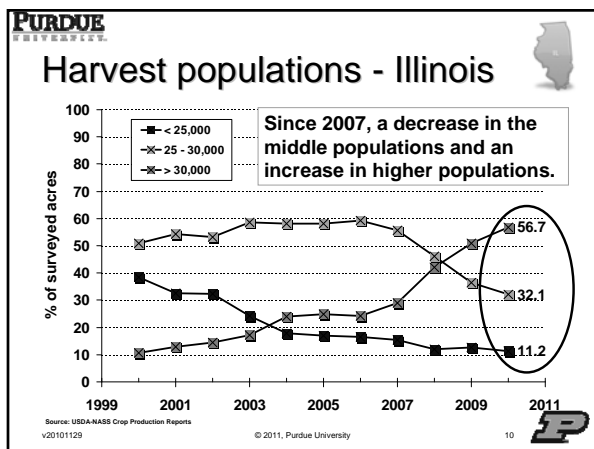
Harvest populations - Illinois

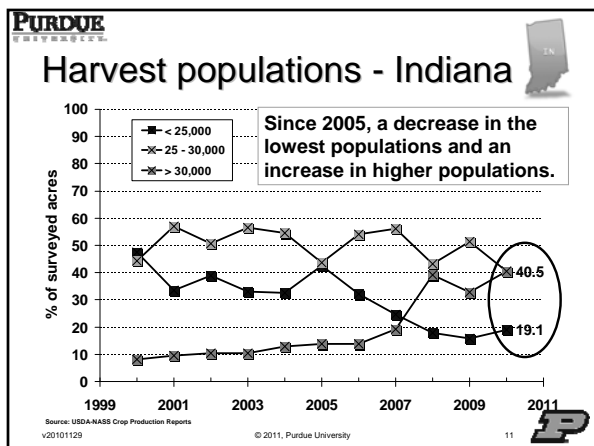


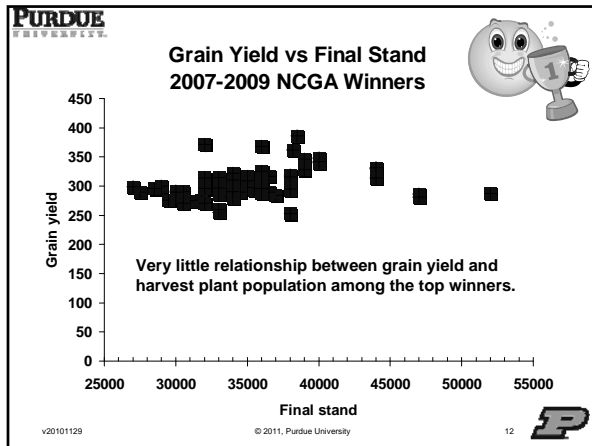
Average harvest populations reported by Illinois corn growers have been steadily increasing by about 370 plts/ac/yr over the past 20 years.

Source: USDA-NASS Crop Production Reports
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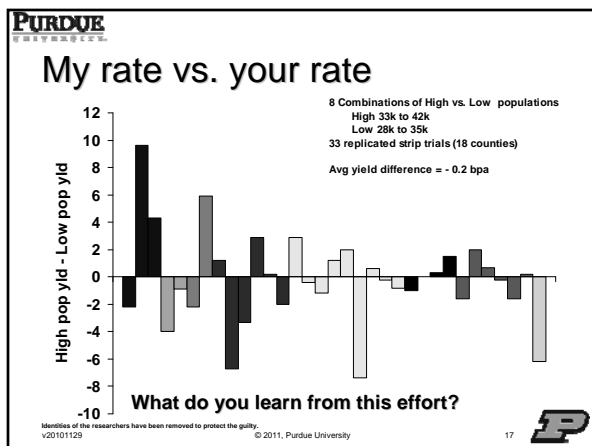


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Identifying optimum seeding rates

- Seeding rates represent a quantitative input, so ought to develop a yield response curve to estimate optimum rate.
 - Similar to how we evaluate N rates.
- Simply comparing one rate vs. another may answer which is superior, but does not offer best estimate of optimum rate.

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Yield response to seeding rates

- Is not feasible to evaluate yield response to every possible seeding rate alternative.
- So.....we evaluate yield response to four to six seeding rates that represent the range of possible seeding rates and then develop a yield response curve.
 - E.g., 29k, 34k, 39k, and 44k seeding rates.

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Yield response to seeding rates...

- Lower and higher than optimum seeding rates included to capture full range of yield response.

Rate lower than optimum Rate higher than optimum

Figure 1. Corn grain yield at varying seeding rates

Seeding rate per acre (x1000)	Percent Maximum Yield
22	95
28	98
34	100
40	98
46	95
50	92

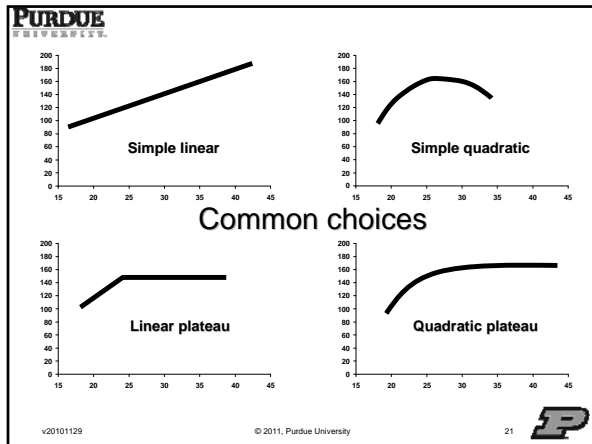
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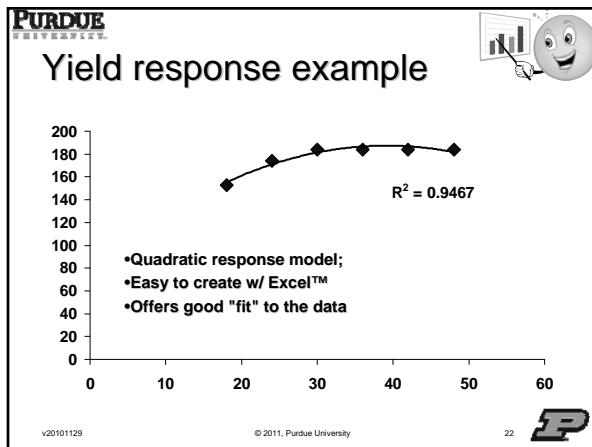
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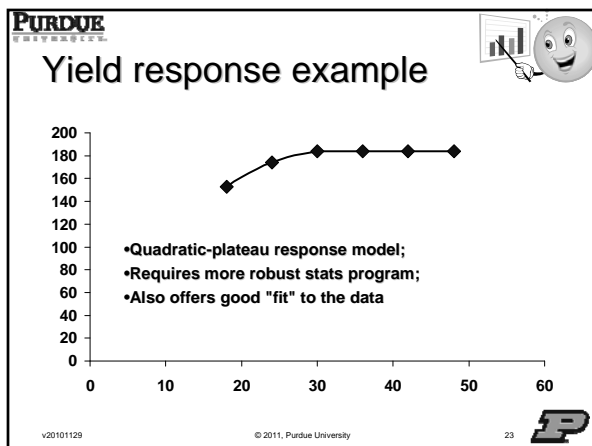
Choice of response curves

- To describe yield response to plant density, there are alternative “shapes” of response curves to choose from.
 - Statistically, one or two or all of them may offer good “fits” to the data set.
 - Is a certain amount of responsibility on the researcher’s part to choose the model that visually reflects the yield response to the actual data.

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Why does this matter?

- Choice of model can influence estimation of optimum plant population.

Quadratic model
Optimum density - 39k

Quadratic plateau model
Optimum density - 32k

With seed corn ~ \$3 per thousand.....

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More “curve balls”

- Sometimes, you have no business trying to fit a yield response curve to the data.
- In other words, sometimes there is no yield response.

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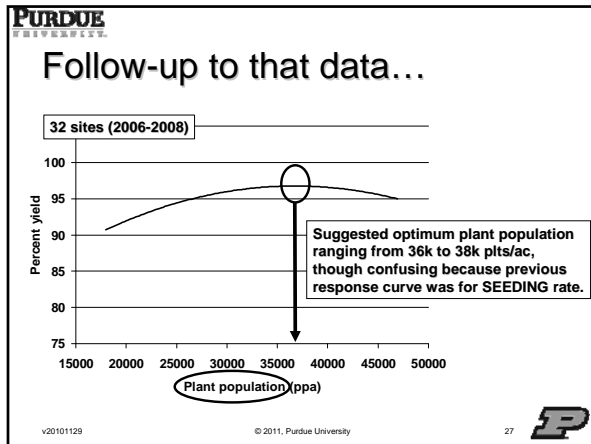
An example...

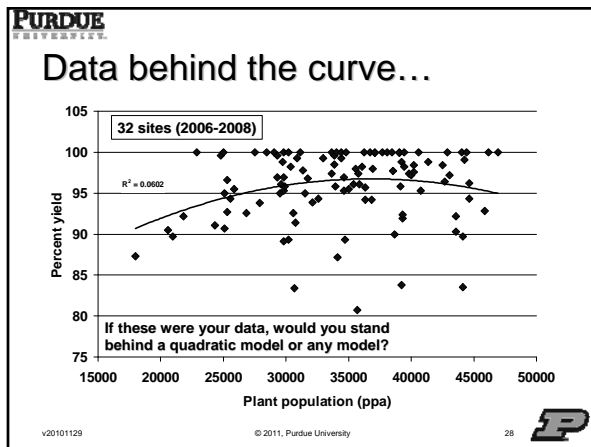
- Recent public data suggested an agronomic yield plateau occurred close to 36,000 seeding rate.
- Supporting data points not shown.

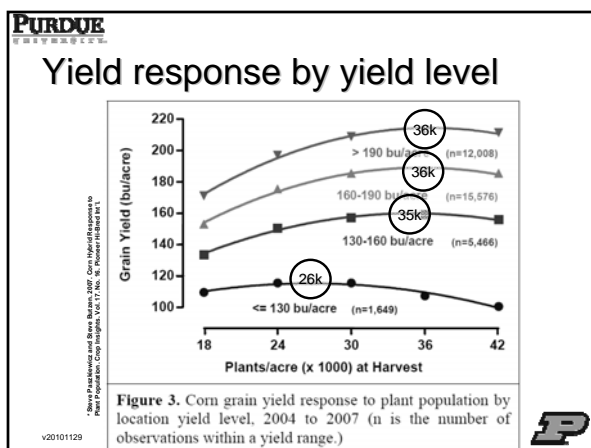
10 locations, 2006*

Figure 1. Corn grain yield at varying seeding rates

* Identities of the researchers have been removed to protect the guilty.
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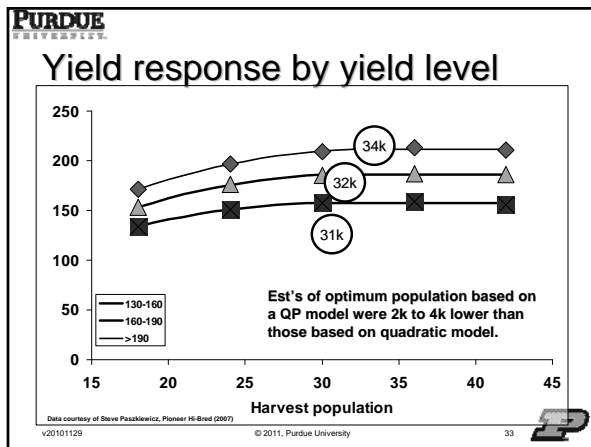
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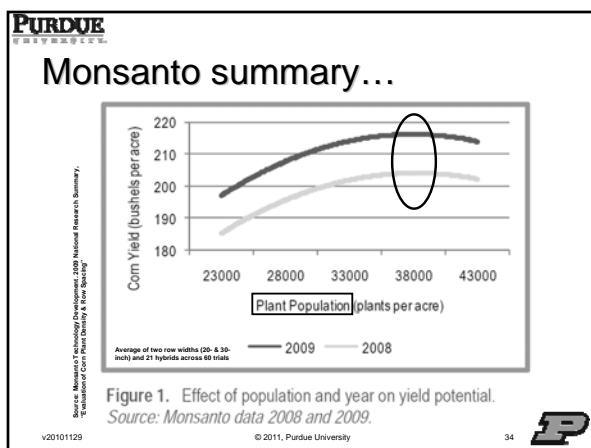
Whoa....let's take another look

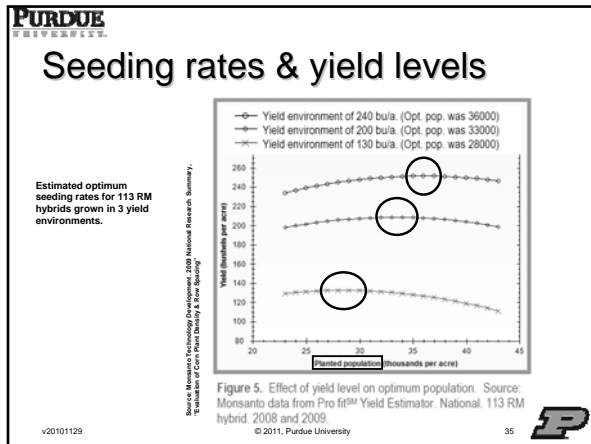
- Those data were analyzed by fitting quadratic curves to the yield response data.
- What if a quadratic-plateau model were used instead?



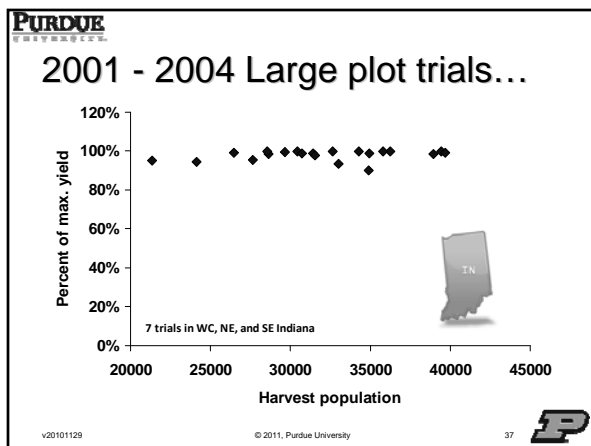
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- Recent university data...**
- Iowa: Suggests optimum final stands level out around 30,000 ppa.
 - Southern IL: Suggests optimum final stands closer to 24,000 ppa (more challenging soils).
 - Northern IL: Suggests optimum final stands near 35,000 ppa.
 - Central/southern MI: Suggests optimum final stands near 36,000 ppa.
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2008 - 2010 Seeding Rate Trials

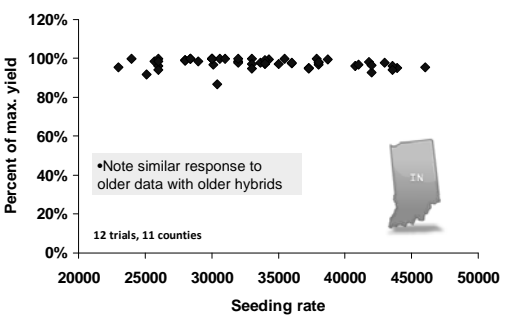
- On-farm, replicated trials to evaluate corn yield response to plant populations.
 - Farmer cooperators using their own farm equipment to plant and harvest.
- Contact your local Extension educator or Certified Crop Adviser if you would like to participate in 2011.



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2008 - 2010 OFR trials...



Percent of max. yield

Seeding rate

12 trials, 11 counties

•Note similar response to older data with older hybrids


TN

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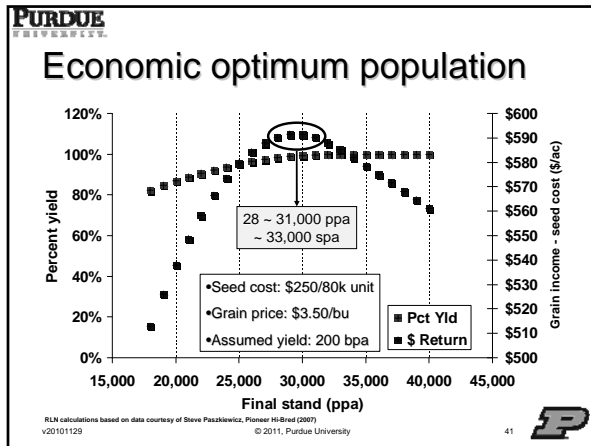
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Seeding rate decisions...

- Are influenced by actual yield response to plant population and the cost of seed.
 - Agronomic optimum seeding rates
 - Maximum yield regardless of cost.
 - Economic optimum seeding rates
 - Maximum \$ return to seed inputs.



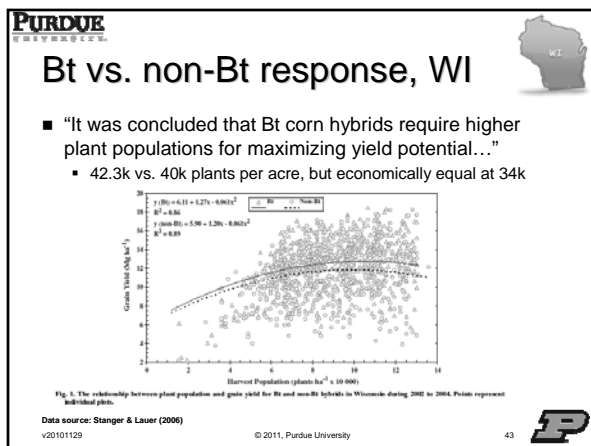
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Today's elite hybrids?


- Some claim that today's elite multiple biotech trait hybrids respond better to higher seeding rates than today's elite non-biotech or simply RR hybrids.
 - However, there is little, if any, independent data to support the claim.
 - Today's hybrids are simply more stress tolerant across the board than those of 20 years ago.

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Bt vs. near isoline hybrids



- Non-Bt vs. Bt-RW or Bt-RW-ECB
- Six site-yrs for corn / soy
Two site-yrs for corn / corn
- Yield responses to plant density equal
 - Economic maximum plant density across all hybrids ranged from 32k in IL to 37k in IA.


Data source: Coulter et al. (2010)
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Seeding rate decisions...

- Are not influenced very much by hybrid.
- Today's hybrids in general have much better population tolerance than their predecessors.
 - Improved ability to maintain ear size at higher plant densities.
 - Less tendency to remobilize stored stalk carbohydrate reserves during stressful grain fill; thus less tendency for stalk lodging at higher plant densities.




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Image: <http://pascamerdoky.files.wordpress.com/2007/07/balancing-act-001.jpg>




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Stalk health concern...

- Remains an issue for hybrids with moderate or worse stalk strength or stalk rot resistance.
- Such hybrids should be planted at more moderate seeding rates to minimize the risk of severe stalk lodging prior to harvest.




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Image source: http://www.sl.edu/imagegallery/imageGallery_SearchResult.cfm




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Bottom line w/ corn...



- Current data suggest that many growers should be targeting **economic FINAL stands** no less than ~ 30,000 ppa; equal to a seeding rate of ~ 33,000 spa.
- Exceptions being...
 - Lower yielding environments (e.g., 130 bpa or less) where growers should target final populations between ~ 24 to 30,000 ppa.
 - More northern areas where final stands may need to be 33,000 ppa or greater.


v20101129 Image source: <http://www.webinars.org/news/updates/target> © 2011, Purdue University 47



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Well, you might ask...

- What about “fixed” and “flex” ear hybrids?
 - Surely their optimum plant populations differ?




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Good question...

- Hybrids are thought to differ for their ear size response to plant densities.
 - Commonly used terminology includes “flex”, “semi-flex”, or “fixed” ears.
 - “Flex” hybrids are thought to change ear size (kernel number) more dramatically in response to low or high plant density than that of “fixed” hybrids.


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Ear flex: Not well documented

- Interestingly, there is very little scientific literature that documents hybrid ear size response to plant density.
 - What little there is suggests that “fixed” and “flex” hybrids share common plant densities for achieving optimum grain yields.
 - Occasionally, I evaluate such hybrids in plant density demos at our crop diagnostic training center facility.




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2005 Comparisons...

- Two hybrids rated by a seed company as strongly “fixed” or “flex” were planted at 15, 30, 40, & 50k seeds per acre.
 - Random ears were sampled from each plot.
 - Numbers of kernel rows & kernels per row were counted for each individual ear.
 - Total kernels per ear were calculated and expressed as a percent of mean kernel number for 30k seeding rate.

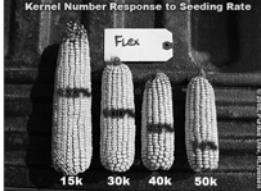


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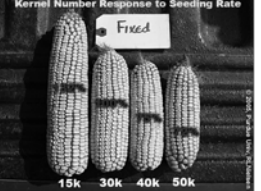
2005 Comparisons...

Kernel Number Response to Seeding Rate




15k 30k 40k 50k

Kernel Number Response to Seeding Rate

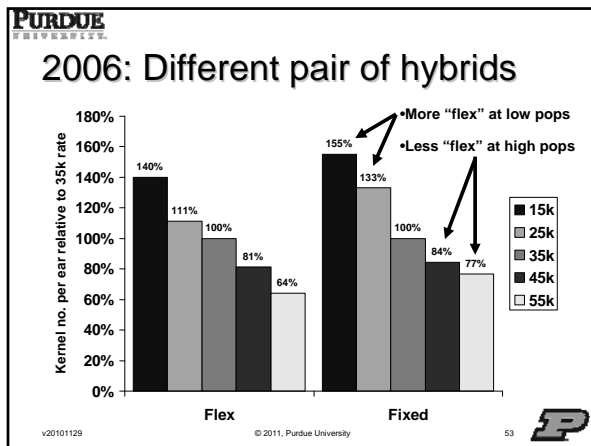


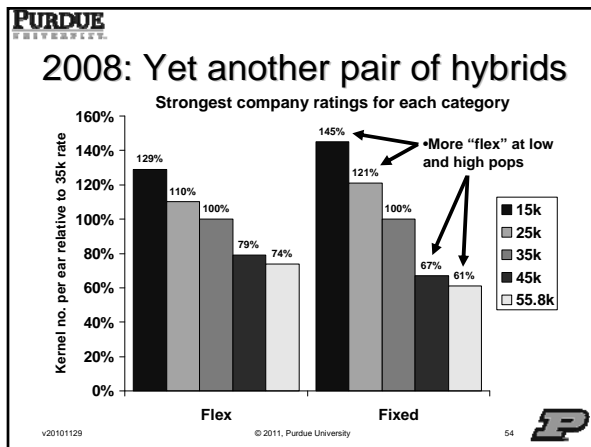
15k 30k 40k 50k

- “Flex” hybrid indeed flexed at both low and high plant densities.
- “Fixed” hybrid flexed more than “flex” hybrid???



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Bottom line...

- Essentially, all hybrids flex ear size in response to changes in plant density.
- Some flex more than others, but apparently not as consistently as some seed companies claim they do.

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Bottom line on seeding rates...


- Current data suggest that many growers should be targeting economic **FINAL** stands no less than ~ 30,000 ppa; equal to a seeding rate of ~ 33,000 spa.
- Exceptions being...
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My opinion on row spacing...


- Traditional 30-inch rows are not a primary limiting factor for corn grain yield today in the heart of the Corn Belt.

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The move to 30-inch rows...

- Was accompanied by a good consensus by public researchers throughout the Corn Belt that 30-inch rows would yield 6 to 7 percent better than 36- or 38-inch rows.
- But, what about a move from 30-inch rows to narrower rows today?
 - Has garnered farm press attention for years.

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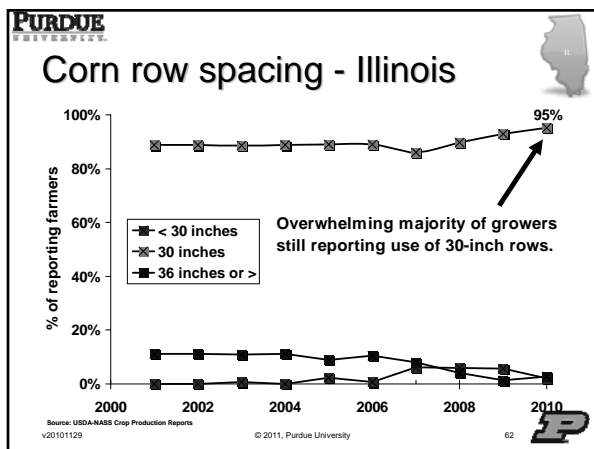


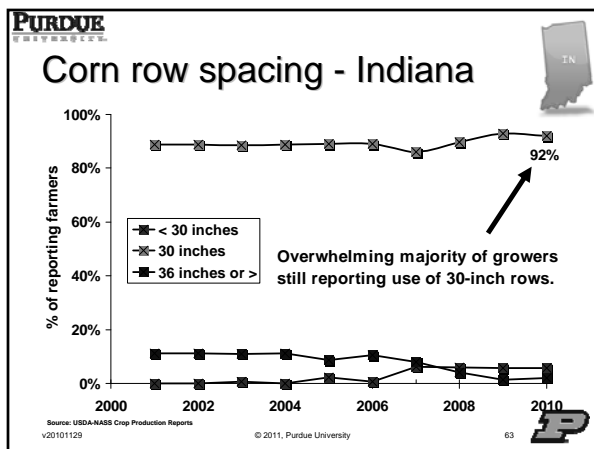
Some folks say...

- “I’m gonna switch to 20-inch rows because I hear the “big boys” are doing it and are harvesting 20 to 40 more bu/ac!”
- “I’ve heard that narrow rows don’t work until you push populations to 45,000.”
- “There’s been a rapid adoption of narrower rows in recent years.”

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Row spacing decisions are...

- Influenced by machinery issues:
 - Equipment tire size
 - Post-planting operations
 - Planters & seed meters
 - Combine headers
 - Row irrigation
 - Compatibility with other crops





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Row spacing decisions...

- Are also influenced by the crop's yield response to narrower rows...
 - Primarily related to plant-to-plant competition for available water, nutrients, and light.
 - If more than enough water, nutrients, & light; then NOT likely to see a significant response to narrower rows.




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Image source: <http://www.nabkam.com/PrecisionAg.html>

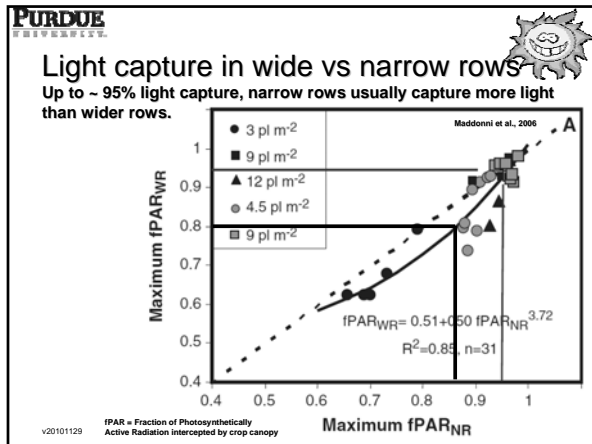
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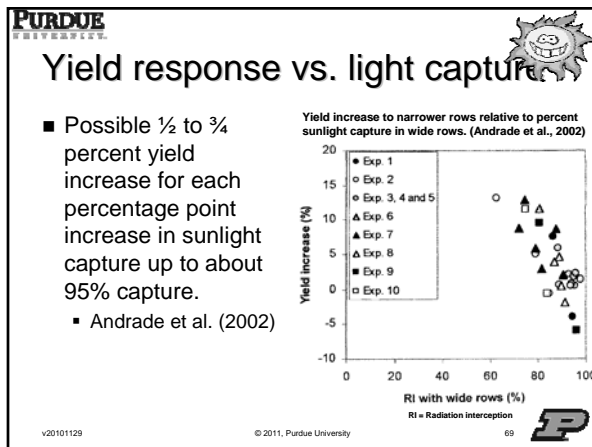
Response to row spacing...

- Is also related to whether the crop canopy is "capturing" at least 95% of the available sunlight **during flowering or beyond.**
 - Barbieri et al. (2000), Maddoni et al. (2006)



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Consequently...

- Narrow rows may be most beneficial where canopy development & yield are challenged by marginal soils or climates.
 - Northern climates (cooler, less growth).
 - Nutrient deficient soils (esp. nitrogen).
 - Sandy, non-irrigated, often droughty soils.
 - Shorter-season hybrids.
 - Smaller, shorter, less leafy hybrids.

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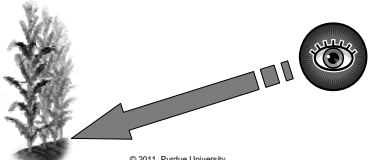
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Use your eyes...

- Estimate % light capture by estimating % shade beneath the crop canopy shortly after noon on a sunny day in early July.
 - If less than ~ 95% shade, then likely not at maximum yield potential.



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Most public research...

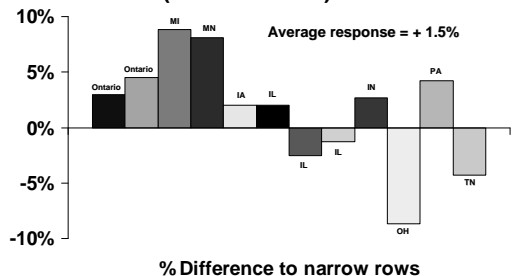
- Indicates that yield response to row spacing narrower than 30 inches is generally positive, but **very inconsistent**.
 - Averaging 1.5 to 2.5% advantage.
 - Most have found that optimum seeding rates are similar for different row widths.

Image source: <http://www.answers.com/topic/grain-belt>
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Reported Responses to Narrow Rows (15- or 20-inch) 1984-95

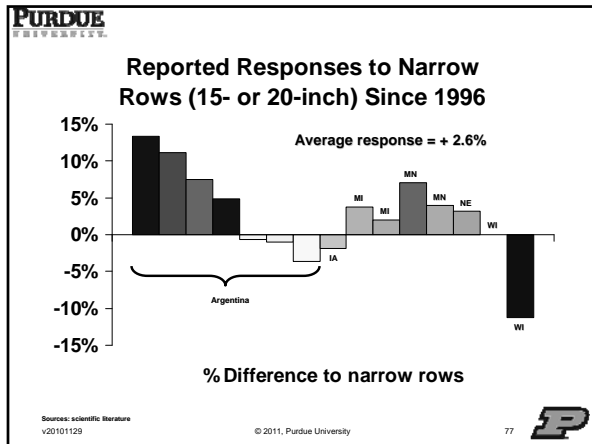
Average response = + 1.5%

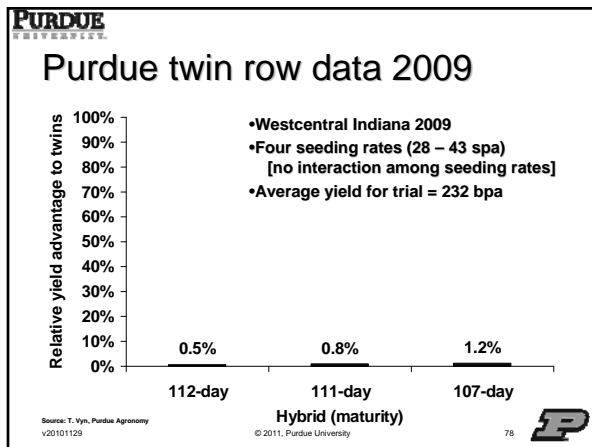


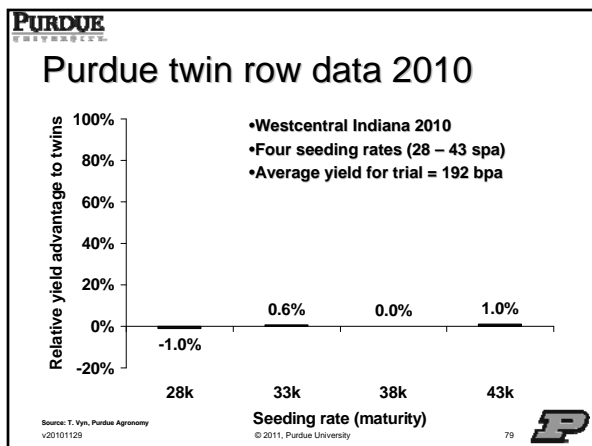
State	% Difference to narrow rows
Ontario	~3.5%
MI	~8.5%
MN	~7.5%
IA	~2.5%
IL	~2.5%
IL	~-2.5%
IL	~-1.5%
IN	~3.5%
PA	~4.5%
OH	~-8.5%
TN	~-4.5%

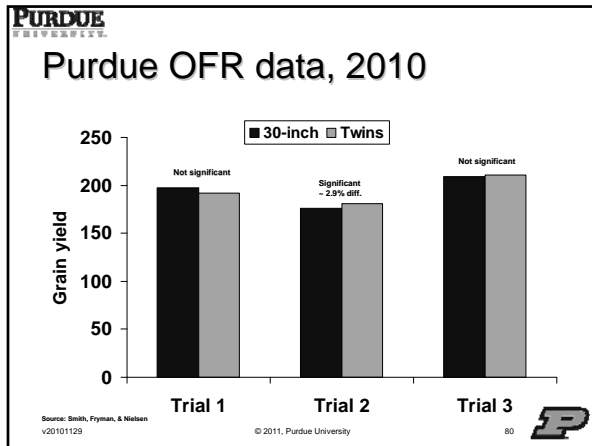
% Difference to narrow rows

Source: Paszkiewicz, 1996
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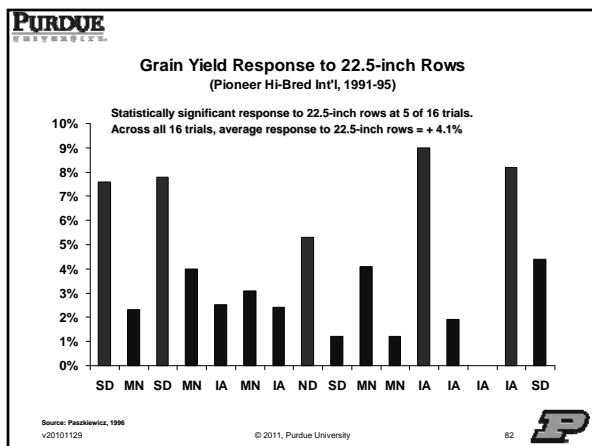


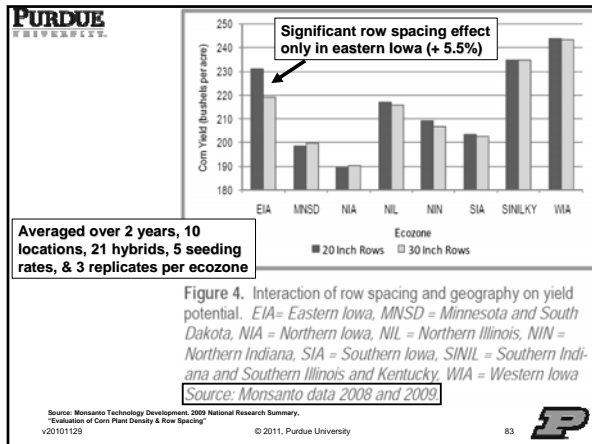


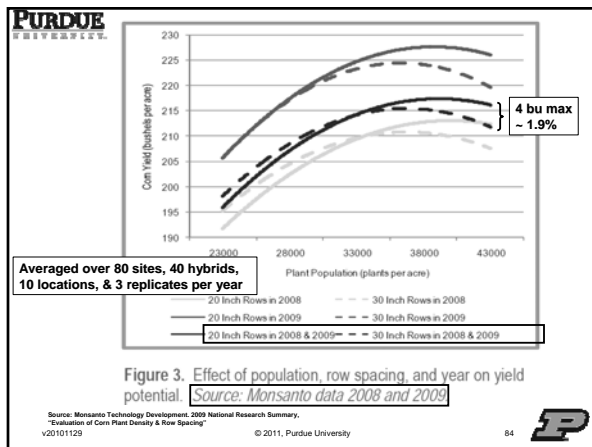
Data from industry sources...

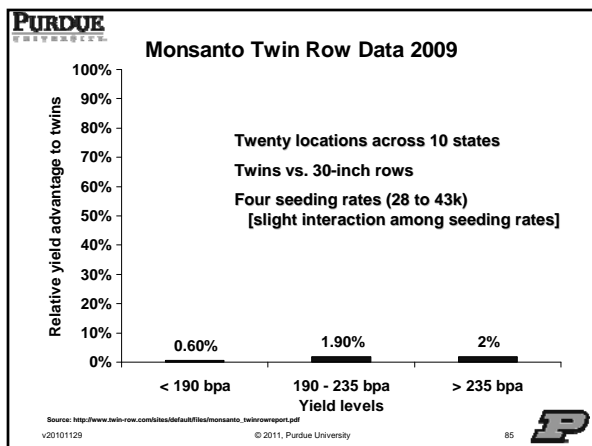
- Varies, but tends to show similar relatively low percent yield responses for narrow rows; including twin-row configurations.

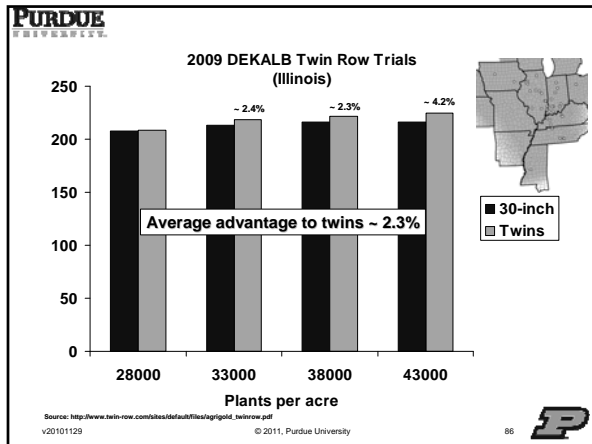
Source: Paszkiewicz, 1996
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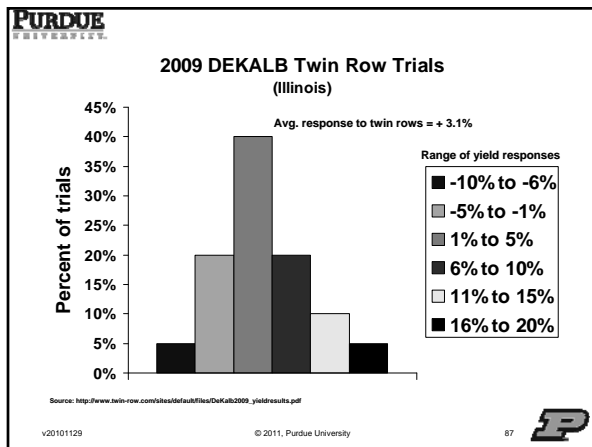












Other reports of higher yields...


- Are more difficult to assess because details of the comparisons are not clear.

Source: http://www.twin-row.com/files/default/files/DeKalb2009_yieldresults.pdf
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Other reports of higher yields...


- Not uncommon for on-farm trials to compare 30-inch rows planted at one seeding rate with a narrow row spacing at a higher seeding rate.
 - 30-inch rows @ 28k
 - 20-inch rows @ 35k



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Other reports of higher yields...




- In some cases, I suspect that documented yield increases to narrow rows may be related to slower seed metering and more uniform stand establishment when planting at aggressively high seeding rates and fast planting speeds.

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Bottom line on row spacing...

- Traditional 30-inch rows are not a primary limiting factor for corn **grain yield** today in the heart of the Corn Belt.
- Profitability depends on costs to change, acreage, potential yield, & grain price.



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