Developing Relationships with On-Farm Research

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On-Farm Research

1. Research compared to "strip tests" or "practical research"
2. Key components of good research
3. An example or two
4. Time expectations

Why do Research?

- Companies don't need it to sell product
- Farmers don't understand research
- Farmers do understand 5 bu/acre
- Some of us don't understand the difference

Trade Secret:

- Some companies use research to advance products, internally and to get approval from EPA, USDA, FDA, etc.
- They use good marketing to sell their products.

Why do Research?

- Excellent data is the backbone of extension recommendations.
- Excellent data comes from research.

Why do On-Farm research?

- Farmers tend to believe what they see on their farm.
- We are in the business of excellent data.
- We're also in the business of good relationships.
- On-farm research allows us to do both.

Example of a bad data study…

- We sprayed a fungicide over the whole field but we left one strip. We got 5 bu/acre increase.
- Conclusion: Fungicides will work on all of our farms and in all years.

Rabbit Trail… is 5 bu/A a lot?

Initial Yield, bu/A	Increase, bu/A	Increase, %
200	5	3%
100	5	5%
50	5	10%
25	5	20%

- It's hard to see 5% changes in field research.
- So, 5 bu/acre in field research is usually "no difference"
- To a farmer, 5 bu/acre is a lot!

Do Past Results = Future Performance?

- Kentucky won the NCAA Men's Basketball National Championship in 2012.
- Does that mean Kentucky will win in 2013?

Kentucky has won 8 national championships.
Kentucky has won back-back national championships once: 1948, 1949

Do Past Results = Future Performance?

- Your corn was knocked flat from a storm last year.
- Does that mean it will get knocked flat this year?

Do Past Results = Future Performance?

- Someone used a product and got 5 bu/A.
- Does that mean you will get 5 bu/A?
- Always?
- Every Time?

A simple "Strip Plot"…

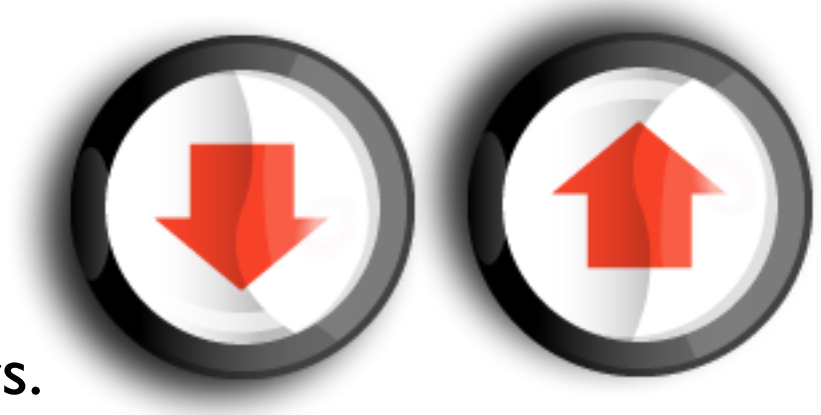
- Tells how you two treatments did.
- Without replicates, you have no way to separate performance from the noise.
- Unless you have many locations.

Flip a Quarter…

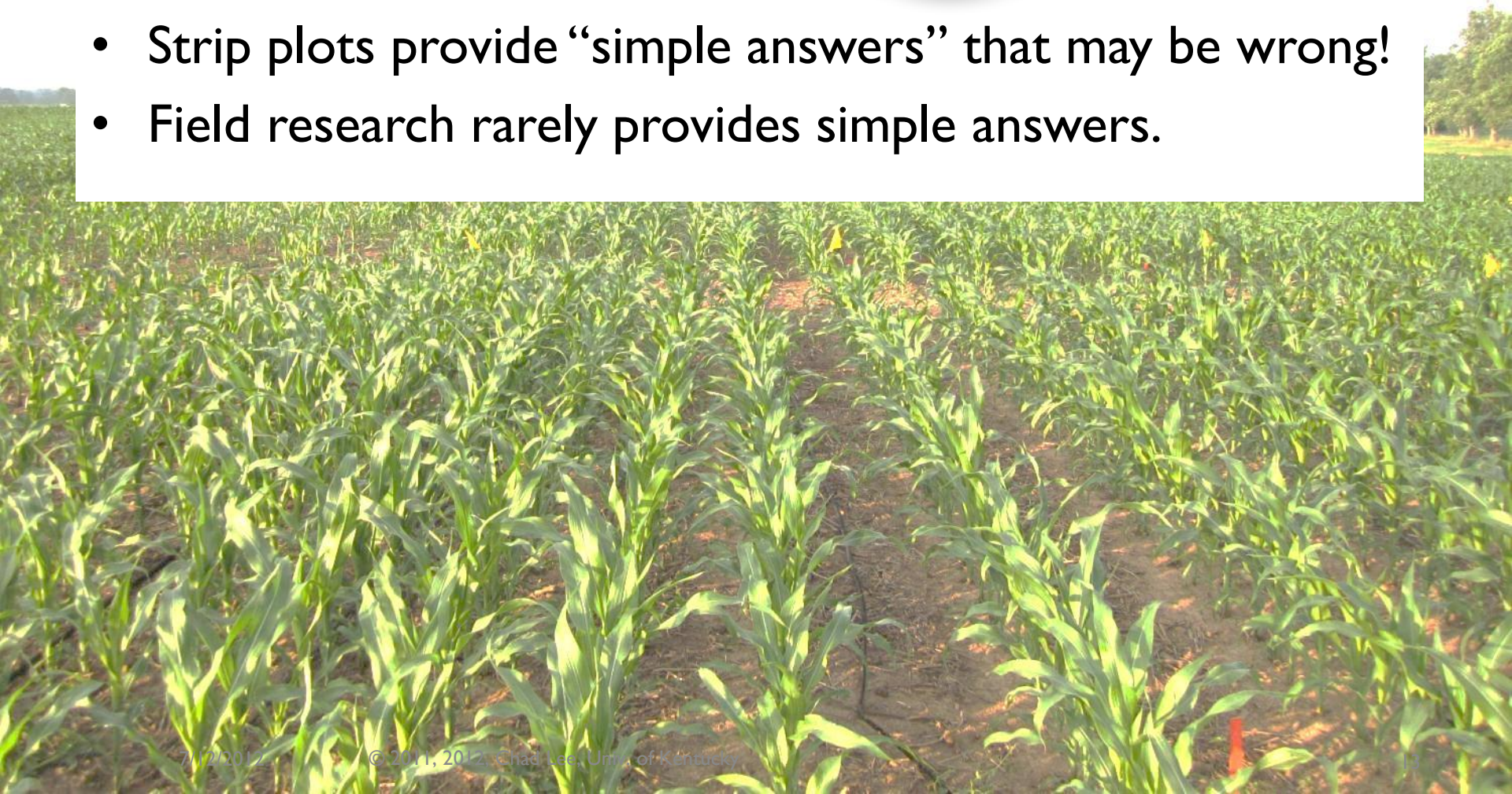
- Do a simple strip-plot
- Compare one product
- Pick 20 locations
- Just by odds, 10 locations should have a higher yield for the product

If 75% or 80% of the locations have higher yields, then we might have something.

Field Research



- Farmers want simple answers.
- Strip plots provide "simple answers" that may be wrong!
- Field research rarely provides simple answers.



Why Do Research?

- To come up with a fact-based answer to a question for which no sound answer previously existed.
- Then use that answer to predict FUTURE performance or response of the crop to some change in management practices.

R.L. Nielsen, Purdue Univ.

2. Key components to good research

Scientific Method

1. Ask a question
2. Develop a hypothesis
3. Devise experiment(s) to test the hypothesis
4. Analyze the results and compare to hypothesis
5. Modify and repeat the experiment

Scientific Method

Process

1. Ask a question
2. Develop a hypothesis
3. Devise experiment(s) to test the hypothesis
4. Analyze the results and compare to hypothesis
5. Modify and repeat the experiment

Example

1. Will narrow rows yield more corn?
2. We think narrow rows will yield more corn.
3. We will test narrow and wide rows. Three replications in three fields.
4. The results say that narrow rows yielded more for one hybrid.
5. Next year, we need to test more hybrids.

Compare your comparison

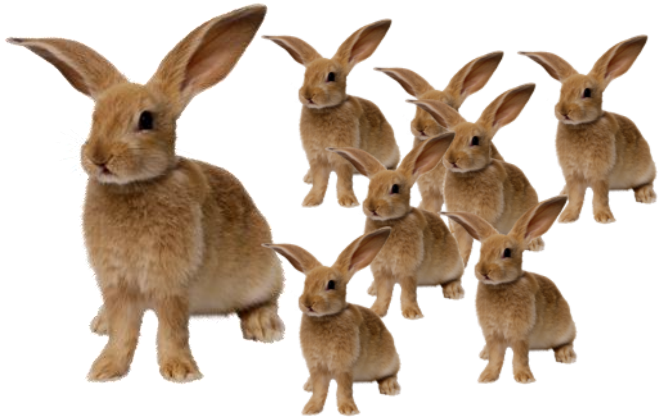
- *If the goal is to test hybrids, then…*

Factor		Factor	
Soil Type	Same	Herbicides	Same
Tillage	Same	Insecticides	Same
Planting Date	Same	Foliar Trts	Same
Seeding Rate	Same	Harvest Date	Same
Seed Treatments	Same	Planting Equip.	Same
Hybrids	**Different**	Spraying Equip.	Same
Soil Fertility	Same		

Replicate… and Randomize

Replication can be….

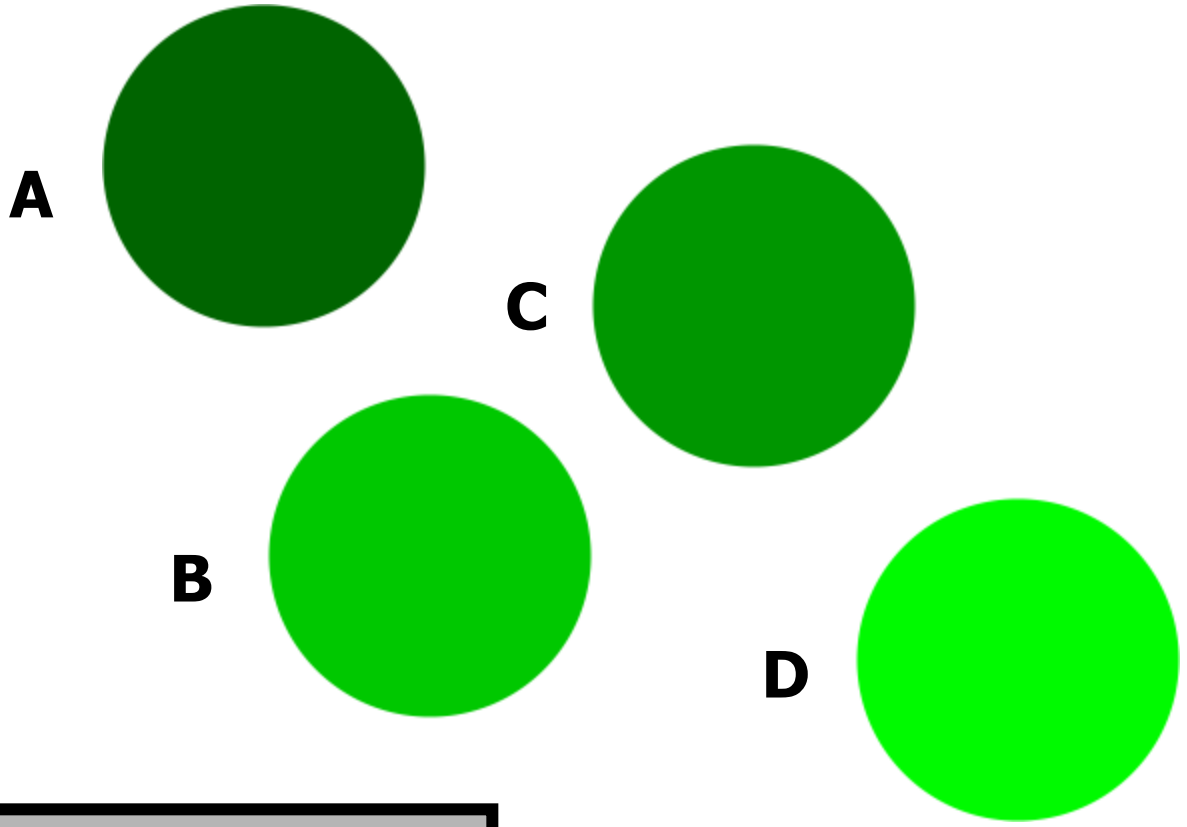
- Different plots in the same field
- Different fields
- Different years
- All of the above



Randomize

- Helps us avoid bias in the study
- Helps us account for error or noise

Which colors are different?



A > C > B > D

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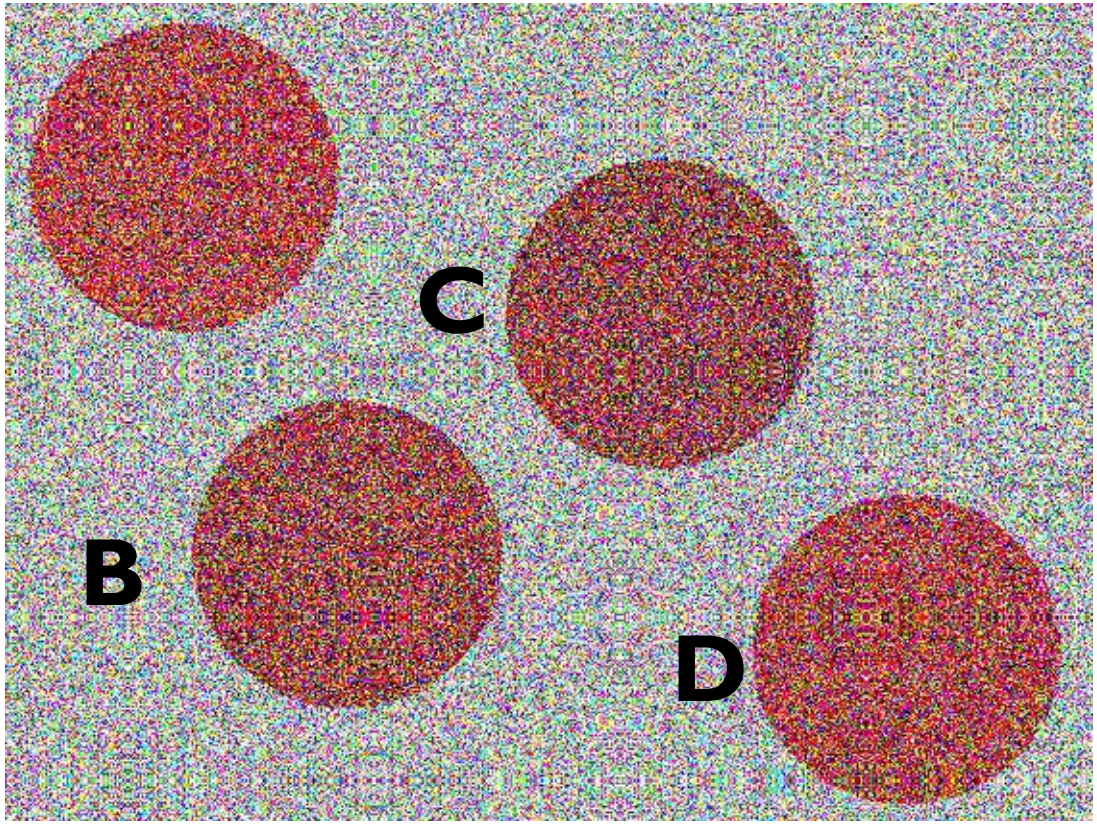
Which colors are different?



Excessive background "noise" can mask treatment effects.

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Is it real, or is it "noise"?

- Field research is always plagued by the confounding effects of background "noise" that tend to camouflage the effects of the treatments being evaluated.
  - Also referred to as "experimental error".
  - Background "noise" consists of variability among plots due to other, uncontrolled, often unknown yield influencing factors.
  - Weeds, soil types, water, compaction, poor stands, etc. can all be noise that masks the treatment differences.

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Shelby County Corn Trial, 2008

Brand	Hybrid	Trait	Hybrid No.	Yield, Bushels/A (15.5% Moist.)
			20	172
			7	180
LSD (0.05)				13

- On-farm study compared 20 hybrids.
- Question: do GMO hybrids yield greater than non-GMO hybrids?
- The two hybrids above were within 8 bu/A, which is less than the LSD of 13 bu/A.
- Are the yields different between the two hybrids?

Shelby County Corn Trial, 2008

Brand	Hybrid	Trait	Hybrid No.	Yield, Bushels/A (15.5% Moist.)
Pioneer	31P41	Base	20	172
Pioneer	31P41	Base	7	180
LSD (0.05)				13

- Slot "20" was open, so the farmer grabbed the same bag of seed that he used for slot "7". We treated the two entries as separate hybrids for analysis.
- Every field has variability. Every field.

Past Results and Future Performance

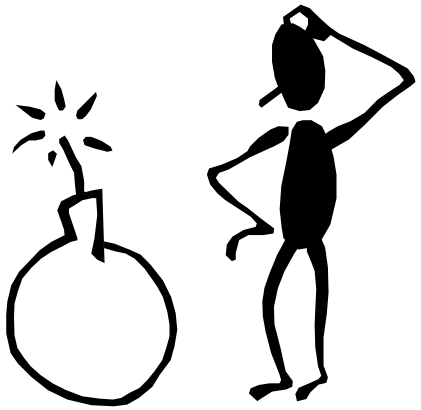
- Statistics helps us address future performance.

Past Results: 5 bu/A difference

Stats say: 10 bu/A difference needed to predict future performance

We say:
"5 bu/A difference is 'not significant' or that there is no difference"

The farmer says: "What?!"



3. Examples of good research

Example of a good research study

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AGRICULTURE & NATURAL RESOURCES

UK UNIVERSITY OF KENTUCKY College of Agriculture

Kentucky Silage Corn Hybrid Performance Report: 2011

Table 1. Corn Hybrid Performance for Silage, Combined Locations (Boyle & Mason counties), Kentucky, 2011.

Brand	Hybrid	Milk Line [1]	Tons/A 35% DM [2]	Milk Yield [3] lbs/Ton	Milk Yield [3] lbs/A	NEL [4] Mcal/lb	NEG Mcal/lb	Quality, % [5] CP	ADF	NDF	Lignin
Asgrow	RX 940 RR2	0.38	**24.1**	3314	27939	0.77	0.50	7.8	25	42	3.4
Becks	6733 HXR	0.42	**23.5**	3486	28577	0.79	0.53	8.1	24	40	3.3
Becks	6903 HR	0.42	**25.3**	3406	30085	0.77	0.50	7.8	24	41	3.3
Caverndale Farms	CF 1026 GT	0.25	21.1	2918	21405	0.66	0.41	6.9	30	50	4.3
Caverndale Farms	CF 907 GTCBLL	0.50	21.9	3135	24004	0.73	0.46	7.7	26	45	3.6
Caverndale Farms	CF 926 GT	0.30	22.0	3315	25606	0.76	0.49	7.6	25	42	3.4
DeKalb	DKC 64-69	0.54	**24.1**	3176	26735	0.75	0.49	7.5	25	44	3.3
DeKalb	DKC 66-96	0.38	**25.4**	**3544**	31421	0.82	0.55	7.5	20	36	2.9
Dyna-Gro	D58VP30	0.33	**26.8**	3445	**32309**	0.81	0.54	7.8	22	38	2.9
Dyna-Gro	V5683VT3	0.42	**25.5**	3245	28907	0.77	0.51	7.7	24	41	3.2
Mycogen	TMF2H918	0.25	**25.2**	3084	27198	0.70	0.43	8.1	28	46	4.6
Mycogen	TMF2W727	0.25	**24.1**	3411	28739	0.78	0.51	7.9	25	41	3.6
NK Seeds	N73V-3000GT	0.46	**23.6**	3109	25642	0.71	0.46	7.6	28	47	3.9
NK Seeds	N82V-3000GT	0.42	**26.1**	3390	30842	0.80	0.53	7.5	22	38	3.1
Pioneer	31G67AMI BLEND	0.38	22.1	3263	25142	0.74	0.48	7.8	26	44	3.5
Pioneer	P1615 HR	0.46	**24.1**	3286	27558	0.76	0.49	7.5	25	42	3.3
Seed Consultants	SCS11HQ38	0.46	21.5	3316	24894	0.76	0.49	8.0	26	43	4.2
Seed Consultants	SCS11HR70	0.42	**24.7**	3290	28320	0.75	0.49	7.3	24	41	3.6
Southern States	SS 818 GENVT3PRO	0.38	**23.5**	3180	26113	0.74	0.47	7.7	27	44	3.9
Southern States	SS 868 GENVT3PRO	0.42	**23.9**	3180	26454	0.76	0.49	7.4	24	41	3.3
Wyffels Hybrids	W7213	0.42	**25.2**	3390	29873	0.80	0.52	8.1	21	37	3.1
Wyffels Hybrids	W8681	0.46	22.0	3469	26729	0.78	0.51	7.8	25	42	3.4
	LSD (0.10)	0.09	3.7								
	CV	24	11.6								
	Grand Mean	0.39	23.9	3288.5	27477	0.8	0.5	7.7	24.8	42.1	3.5

[1] Milk line measures the starch formation on the corn kernel. 0.75 milk line is considered ideal for silage.
[2] Yields adjusted to 35% dry matter; highest numerical yield is bold with gray box; bold yields are not significantly different from highest yield.
[3] Milk Yield was calculated with Milk 2000. Milk per ton of silage was rounded to the nearest ten and milk per acre was rounded to the nearest hundred.
[4] Net energy for lactation (NEL) and gain (NEG).
[5] Quality measurements based on dry weight and are calculated from composite samples at each site

Layout of a Hybrid Trial Replicated and Randomized

Rep 3	6	1	9	7	8	4	10	5	2	3
Rep 2	2	6	9	1	10	8	5	4	3	7
Rep 1	2	6	3	5	8	4	7	1	9	10

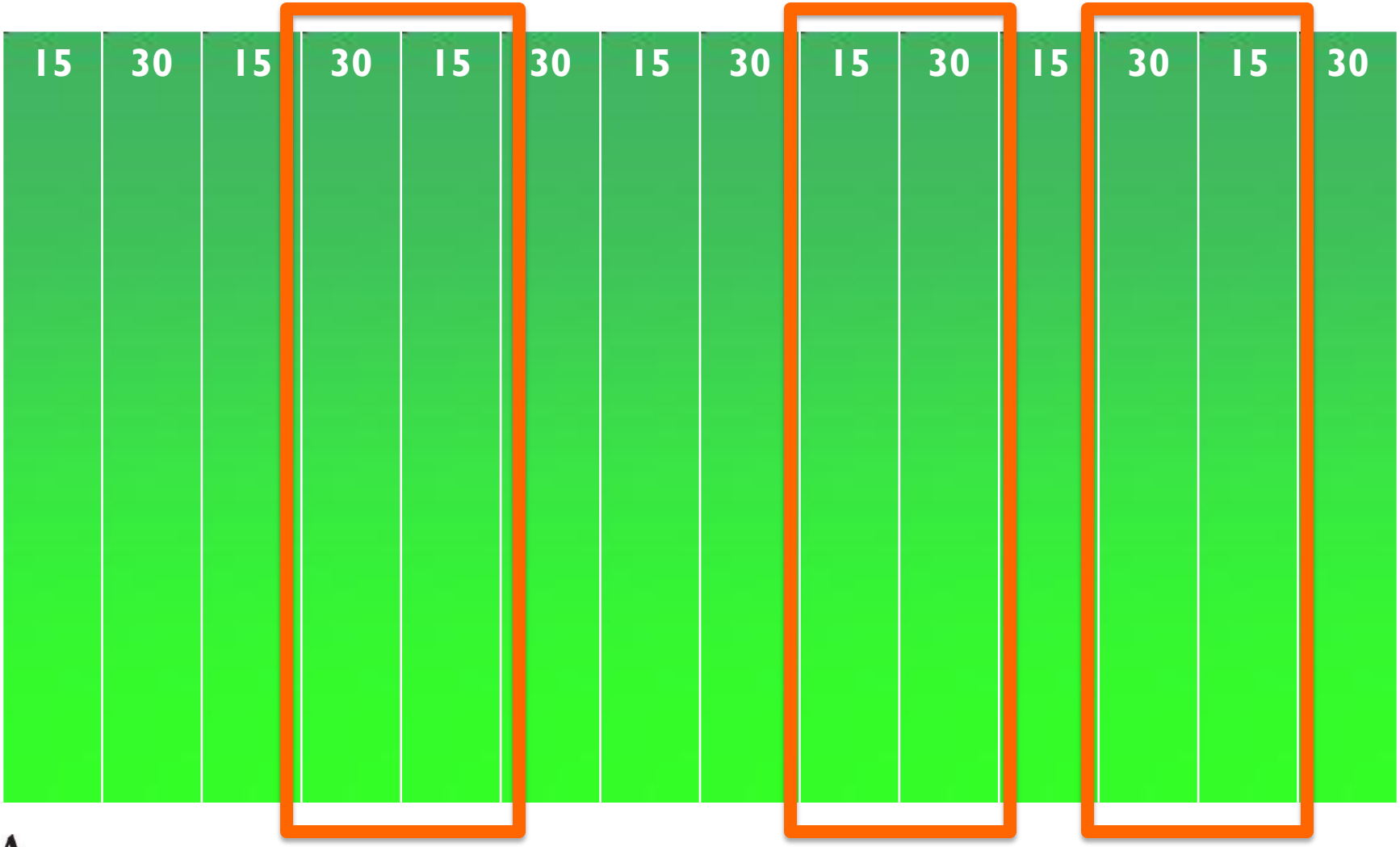
Comparing Row Widths

30 inch rows

15 inch rows

Shelby County, August 16, 2011, R6 Growth Stage

Soybean Row Width Study – Shelby County, KY: 2010 & 2011



15 inches vs. 30 inches

2010 Soybean Row Spacing Study Ellis Farms, Field 23	
Row Width, inches	Yield, Bu/A*
15	93.6
30	93.5
LSD (0.10)	ns

*Adjusted to 13% moisture.

2011 Soybean Row Spacing Study Ellis Farms, Field 23		
Row Width, inches	Moisture, %	Yield, Bu/A*
15	10.7	45.5
30	10.8	43.6
LSD (0.10)	ns	1.6

*Adjusted to 13% moisture

Row Width Comparisons

Populations in Corn

- You want to know if a higher population will result in more corn yield.
- One of the easiest things for most farmers to do these days. Many planters have variable rate technology.

Compare your comparison

- If the goal is to test populations, then…

Factor		Factor	
Soil Type	Same	Herbicides	Same
Tillage	Same	Insecticides	Same
Planting Date	Same	Foliar Trts	Same
Seeding Rate	**Different**	Harvest Date	Same
Seed Treatments	Same	Planting Equip.	Same
Hybrids	Same	Spraying Equip.	Same
Soil Fertility	Same		

Row Width and Population Effect on Yield, Larue County and Lexington, KY, 2011

3 replications at each location, randomized

	Larue County				Lexington	
	DKC62-97	A6533	P1480HR		DKC62-97	A6533
Plants/Acre	Bu/A	Bu/A	Bu/A		Bu/A	Bu/A
30,000	227.7	235.3	197.8		260.0	263.2
35,000	254.8	240.7	203.1		260.0	263.2
40,000	221.9	227.5	180.4		260.0	285.5
45,000	229.1	230.2	171.5		267.9	275.9
LSD (0.10)	38.3	28.7	28.7		11.2	11.2
	15%	12%	14%		ns	4%

Differences less than 5% are difficult to see in research.
Field variability is simply too high in most fields.

Population Results

- For 3 hybrids at Larue: 35,000 was the best
- At Lexington, two of the hybrids did better at 40,000 and 45,000 seeds/acre
- Why?

  Lexington: Irrigated

  Larue: Not Irrigated

On-Farm Research

- Focus on the question
- Randomize
- Replicate
  - Randomized Complete Block Design
  - Completely Random Design
  - Check-Strip Design

Reasonable Time Expectations

Everything takes time.

Task	Estimated Time (days)
Gathering hybrid seed, chemical, etc.	0.5 to 1
Work through details with farmer	0.5 to 1
Planting	1
Harvest	1
Summarizing data	0.5
Scouting for stand, pests, lodging, etc.	1.5
Total	5 to 6

Checklist: Before Planting

___ Visit with farmer about objectives of the trial. Identify soil type, crop history, weed history, etc. of proposed field. Determine planting and harvesting capabilities. Determine cooperator's interest in the project.

___ Develop a plot plan (possibly in a notebook), plus a copy for the cooperator (be ready to make changes to the plot plan on the day of planting)

___ Alert the producer that laying out the plots will require 30 minutes to one hour BEFORE planting

___ Arrange for additional help (if needed)

Clint Hardy, Daviess County ANR Extension Agent, Owensboro, KY

Checklist: Before Planting

___ Know combine width in advance to know planter box layout

___ Know the total number of passes in the plot and know the width of the entire study – be sure the plot will not encounter a ditch, fencerow, etc.

___ MOST IMPORTANT – invite cooperator to provide input/suggestions for what they would like on their farm. They are donating land, equipment and time; the project should be of interest to them.

Clint Hardy, Daviess County ANR Extension Agent, Owensboro, KY

Checklist: Day of Planting

___ Plot plan (possibly in a notebook), plus a copy for the cooperator

___ Seed

___ flags (or similar markers or GPS)

___ two-way radios (walkie-talkies, cell phones)

___ 100-foot to 300-foot tape to measure plots

___ alert the producer that laying out the plots will require ½ to one hour BEFORE planting

Clint Hardy, Daviess County ANR Extension Agent, Owensboro, KY

Checklist: Day of Planting

___ additional help (if needed)

___ latex or nitrile gloves (safety for handling treated seed)

___ soil thermometer

___ planter, in good operating condition

___ proper seeding depth

___ proper seeding rate

___ proper closing of seed furrow

Clint Hardy, Daviess County ANR Extension Agent, Owensboro, KY

Checklist: Day of Planting

___ empty hoppers, and finger pick-up units before adding test seed

___ know combine width in advance to know planter box layout

___ 3 to 4 5-gallon buckets for dumping seed into (very important if using a check), easier to dump into than sacks

___ Shop Vac and generator if using an air planter or drill

___ duct tape (bags often rip)

Clint Hardy, Daviess County ANR Extension Agent, Owensboro, KY

Checklist: Day of Planting

___ know the total number of passes in the plot and know the width of the entire study – be sure the plot will not encounter a ditch, fencerow, etc.

___ BE ON TIME or call in advance. The farmer needs to be planting, not waiting

___ If a single pass is to be made with each hybrid, then borrow a Gator or Mule to carry seed and buckets to other end of field.

___ MOST IMPORTANT – invite cooperator to provide input/suggestions for what they would like on their farm. They are donating land, equipment and time; the project should be of interest to them.

Clint Hardy, Daviess County ANR Extension Agent, Owensboro, KY

On-Farm Research

- It is rather easy to get data.
- It is difficult to get good data.

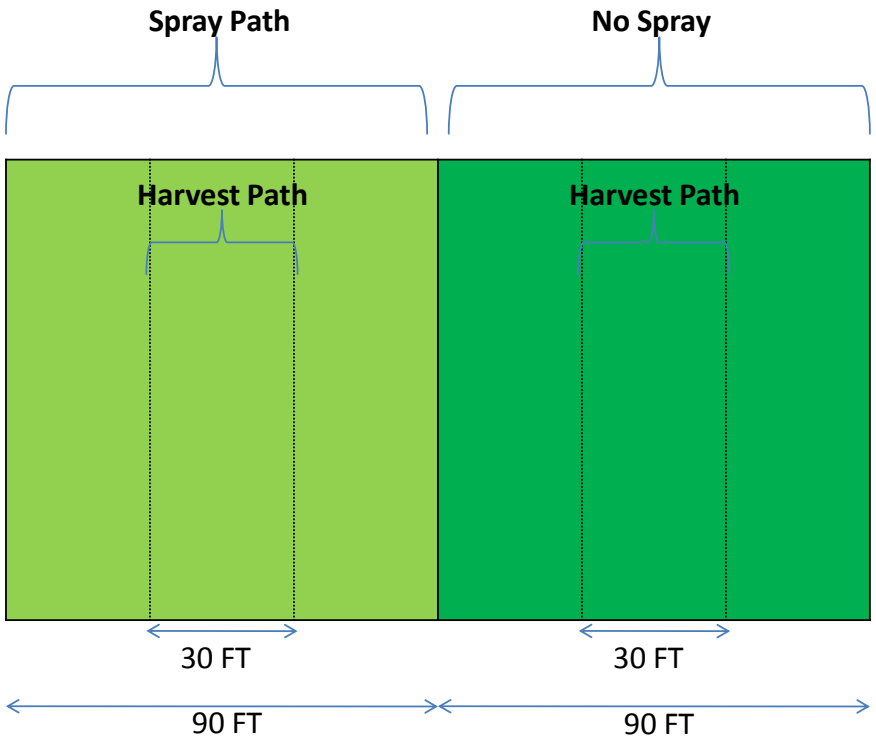
Source: Dr. Lee, but not an original thought. This view is accepted by most field scientists, and I would guess most scientists and analysts.

Study Designs and Options

Keep in mind…

- Be sure to include border rows or plots.
- Find uniform soils in the field… or replicate across different soils
- You may need to make your treatment area smaller than your harvest area (avoid spray overage, etc.)

Treatment Area may be Bigger than Harvest Area



Treatment Area may be Bigger than Harvest Area

Setting up the experiment

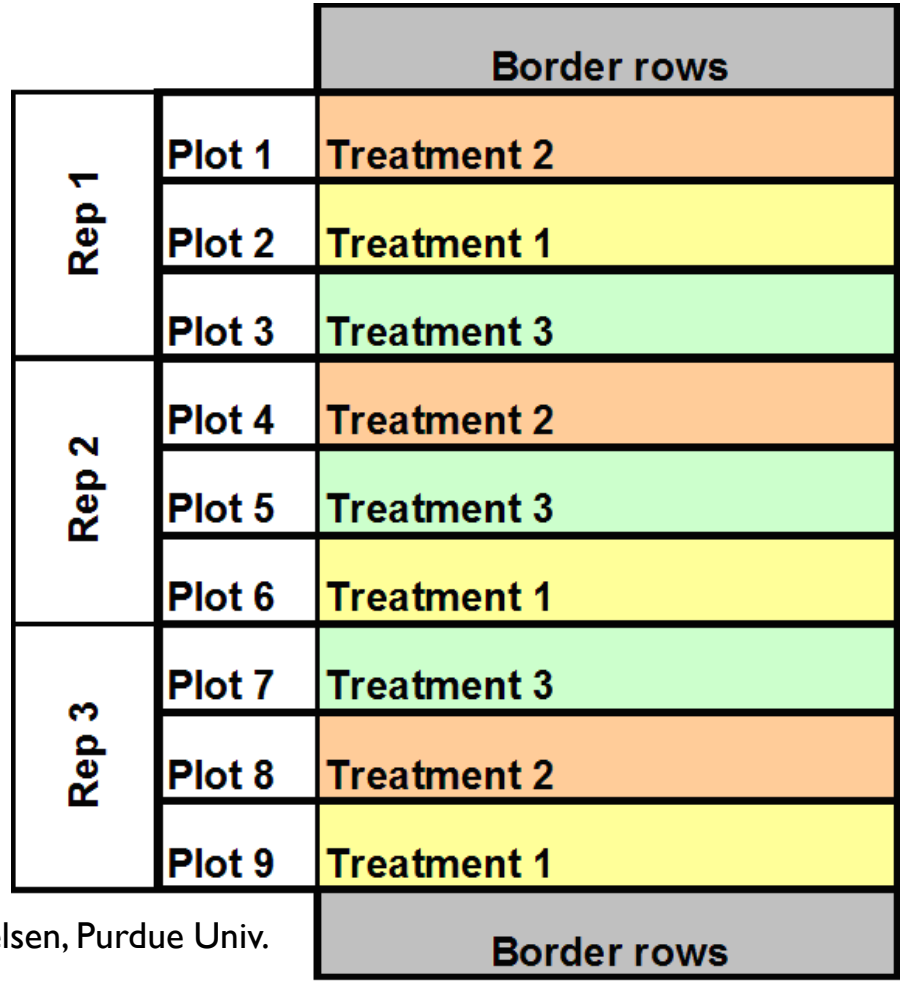
- There are several options for designing field plots.
- Balance between providing the best information possible with the time commitment that you are willing to invest.
- No data at all is better than bad data.

Option 1: RCBD

- Randomized Complete Block Design
- Rigorous design that allows you to account for field variability ("noise").
- Analysis for the RCBD requires a statistical program.
- Many university studies are conducted in RCBD with modified field equipment.

An example of randomization

- Three replicates
- Three treatments
  - Treatment sequence is randomly assigned within each replicate.



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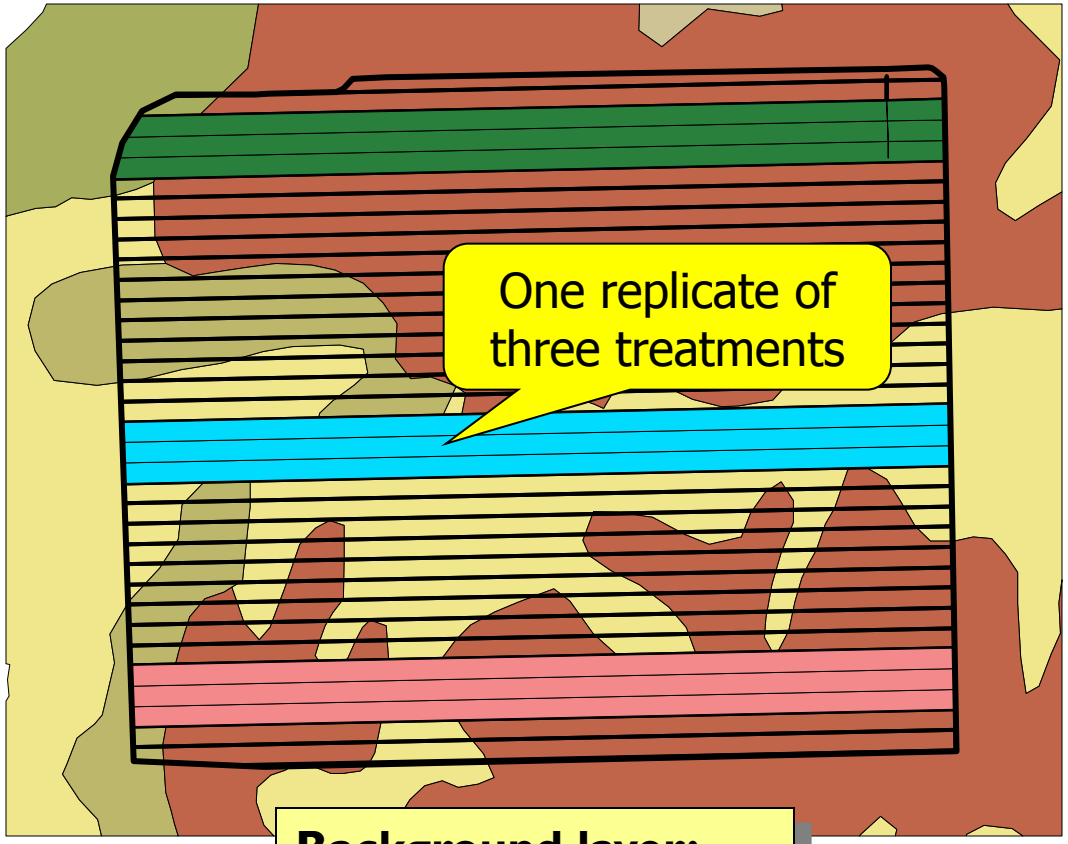
Example of positioning reps

- A 3 treatment trial:
  - 30-acre field
  - 45-ft wide trtmt plots
  - 10 replicates
  - Total of 30 plots
- "Noise" among plots within reps due to soil type variability is reasonably minimal.



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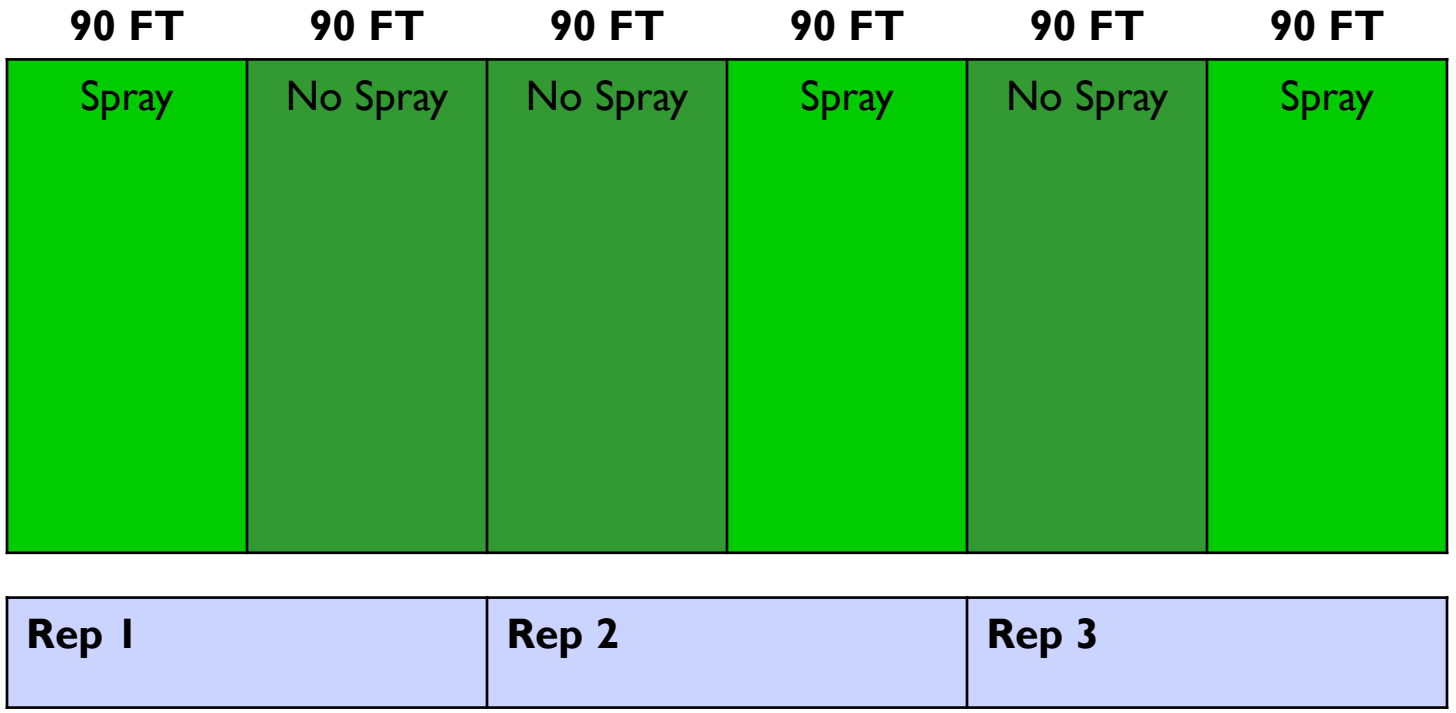
Alternating Strips



- Flip a quarter to decide where to spray and not to spray
- Heads = spray
- Tails = no spray

RCBD: Advantages

- Allows you to measure the noise (variability) in the study.
- Can separate differences between the noise and the hybrids.
  - Using Least Significant Difference (LSD)
- Allows for more confidence in the final results than do other tests.

Shelby County Corn Trial, 2008

Brand	Hybrid	Trait	Hyb No.	Test Weight (lb/bu)	Grain Moist. (%)	Yield, Bushels/A (15.5% Moist.)#	Difference (GMO - Base)	Sig. of Diff.
Farmer Choice	31P41	Base	20	61.3	10.5	171.9		
Pioneer	31P41	Base	7	59.0	10.5	179.7	18.1	***
Pioneer	31P42	HX1RR2	1	60.5	11.5	197.8		
Pioneer	33M54	Base	5	61.8	10.5	167.5	17.4	**
Pioneer	33M57	HX1RR2	3	61.2	10.7	184.9		
NK	71R7	Base	11	59.7	10.3	187.7	2.5	**
NK	72Q6	CBLL	4	59.0	10.9	190.2		
Crows	C4846T	RR2YGPL	10	58.2	10.2	**209.4**	25.5	**
Crows	C4847	Base	8	58.3	10.3	183.9		
Dekalb	DKC61-69	VT3	9	57.7	10.8	**205.3**		
Dekalb	DKC63-42	VT3	14	58.7	10.4	**200.9**		
Dekalb	DKC65-44	VT3	15	60.7	11.0	**211.3**		
Garst	G8348	CLLLRW	19	60.0	10.9	184.5	11.8	**
NK	N77-3000	GTCBLLRW	2	59.8	11.7	196.3		
So. States	SS647	VT3	13	58.5	10.2	196.8	17.8	ns
So. States	SS777	GMO	18	58.8	10.3	179.0		
Exsegen	ES518	Base	12	60.0	10.6	189.8	7.1	ns
Wyffels	W7251	VT3	6	60.0	10.4	197.0		
Wyffels	W8680	Base	17	58.5	10.6	194.3	3.0	**
Wyffels	W8681	VT3RR2YGCB	16	58.5	11.3	197.3		
LSD (0.05)				1.3	0.7	13.4		
CV				1.6	4.4	5.1		
Average				59.5	10.7	191.3	12.9	

RCBD: Disadvantages

- Complicated to set-up.
- Typically need to lay out markers or flags first.
- A larger number of treatments may make this comparison difficult with large-scale farm equipment.
  - Much harder to compare 20 hybrids with this method.
- Need a very patient farmer.
- Need a computer program to calculate error and LSD.

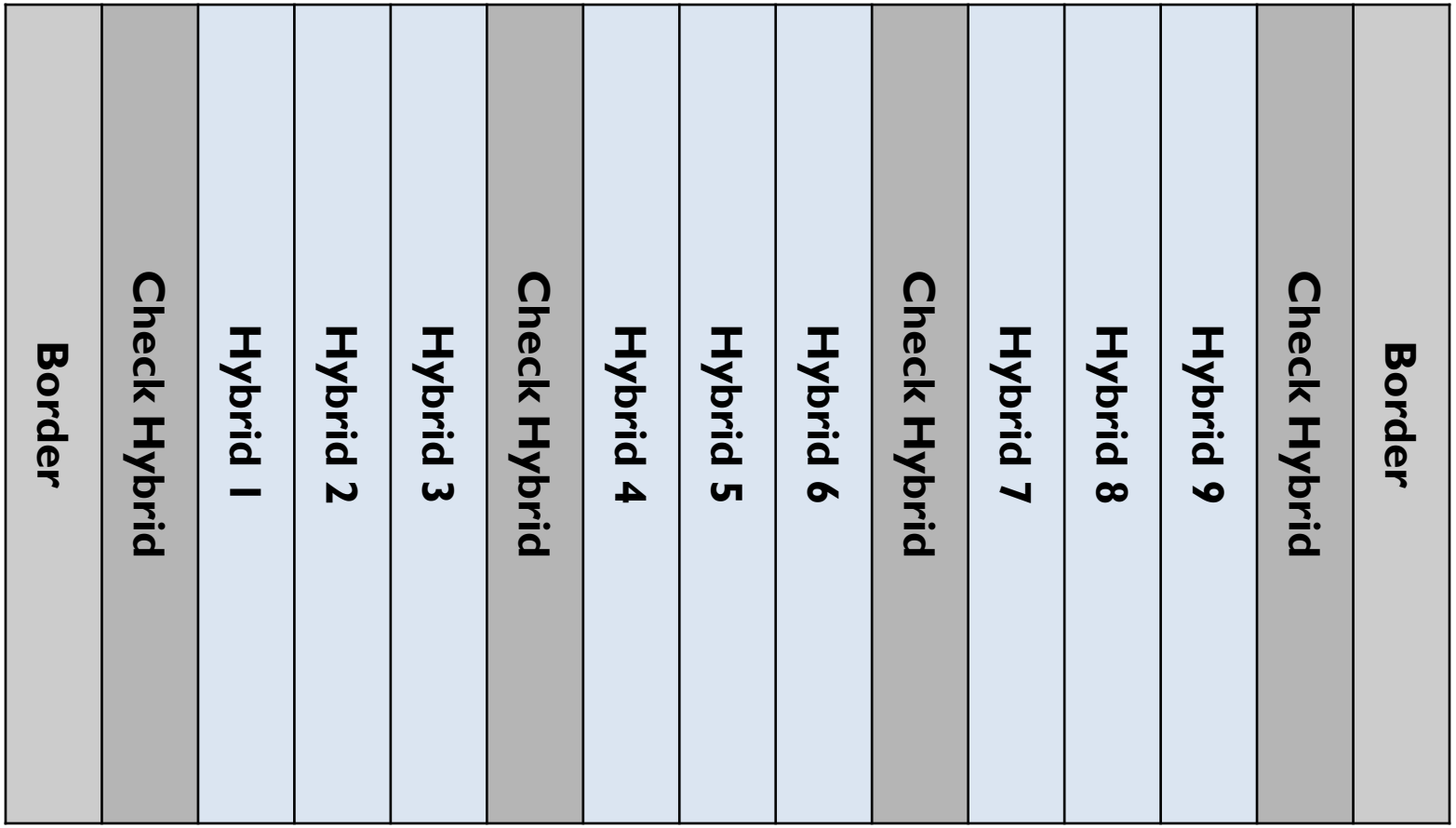
RCBD: Reporting Data

- The data can be reported based on highest yield.
- "Noise" or Variability in the field can be reported as well.

Option 2: Check Strip

- The check strip trial evaluates each treatment once across a field.
- These treatments are compared to a check-strip that is repeated across the field.
- The check-strip must include a check at each end of the study for the proper comparisons to be made.

Check Strip Example



Check Strip: Advantages

- Relatively easy to set-up.
- Accounts for some noise (variability) in the field.
- Can easily incorporate more treatments.
- Easy to use farm-scale equipment.

Check Strip: Disadvantages

- Not as rigorous as the RCBD.
- More difficult to identify an unusual event within a treatment in the field.
- Adjusting yields according to the check-strips can be complicated at first.
- Must report data in order of entry.
- We have an Excel sheet with the formula included.

Check Strip: Reporting Data

- Data should be reported in order it was planted.
- Average yield of entire study.
- Average yield of all check-strips.
- Notes about whether yields tended to be higher at one of the field than another.

Taylor County, 2008

Hybrid*	Test Weight	Moisture %	Lodge%	#2 Yield Bu/Acre	Adj. Yield**	Rank
W7387 (check)	60.5	14.5		197.0	**205.5**	**21**
CR4842	58.3	14.9		203.0	**211.3**	**19**
SS67	59.6	14.2		215.4	**223.7**	**12**
DK6172	58	14.7		222.8	**231.0**	**3**
W7387 (check)	58.2	14.9		198.6		
DK6173	59.3	14.2	7	223.6	**227.7**	**8**
DK6169	57.4	15		224.2	**224.7**	**11**
DG57V44	58.4	14.3		226.0	**223.1**	**14**
W7387 (check)	60	14.3	4	211.3		
P33N55	59.4	14.7		220.4	**217.7**	**16**
W7642	57.1	15.3	4	227.0	**227.9**	**6**
SS661	57.2	15.1		214.4	**218.8**	**15**
W7387 (check)	59.1	14.3	9	198.1		
P33F85	58.6	15.6		204.7	**199.4**	**24**
DK6342	58.4	14.1	3	229.0	**223.4**	**13**
DG57V30	61.1	14.8		209.8	**205.0**	**22**
W7387 (check)	59.6	14.5		210.0		
DG57K71	59.2	14.4	8	213.5	**212.5**	**18**
P33M53	62.2	15.5	15	222.2	**226.4**	**10**
P33N58	60.4	14.5		221.2	**230.9**	**4**
W7387 (check)	59.9	14.4		192.0		
CR5304	60.1	14.8	4	221.3	**227.3**	**9**
P33F88	61	14.9	4	228.0	**232.1**	**2**
SS746	59.7	14.9		209.5	**211.2**	**20**
W7387 (check)	59.2	14.4	17	205.7		
DK6544	60.3	15.2		225.1	**236.8**	**1**
P33M57	62.7	15.7		221.1	**228.5**	**5**
SS777	58.8	16.4		224.0	**227.7**	**7**
W7387 (check)	54.9	15.7		205.6		
W9127	60.2	15.9		218.0	**213.2**	**17**
P31P42	60.3	16.4		209.1	**200.4**	**23**
W7387 (check)	59.9	14.8		223.2		
CF887	59.5	16.3		206.5	**195.3**	**26**
P31G70	59	14.9		213.5	**196.7**	**25**
W7387 (check)	60.6	14.6	7	222.1		

Check Strip Calculations

$$\frac{(\text{mean of all checks})n}{(Ch_1)n_1 + (Ch_2)n_2} \times \text{yield of variety} = \text{Adjusted Yield}$$

- Where Ch_1 and Ch_2 refer to the check strips on either side of the variety and n_1 and n_2 refer to the numbers of strips the variety is away from the Ch_1 and Ch_2, respectively. In addition, n refers to the total number of strips between Ch_1 and Ch_2. The sum of n_1 and n_2 must equal n.

Check Strip, Example

Check Hybrid	Hybrid 1	Hybrid 2	Hybrid 3	Check Hybrid
100 bu	150 bu	130 bu	110 bu	125 bu

$$\frac{(112.5)\times 4}{(100)\times 1 + (125)\times 3} \times 150 = \mathbf{158.8 \approx 159\ bu/a}$$

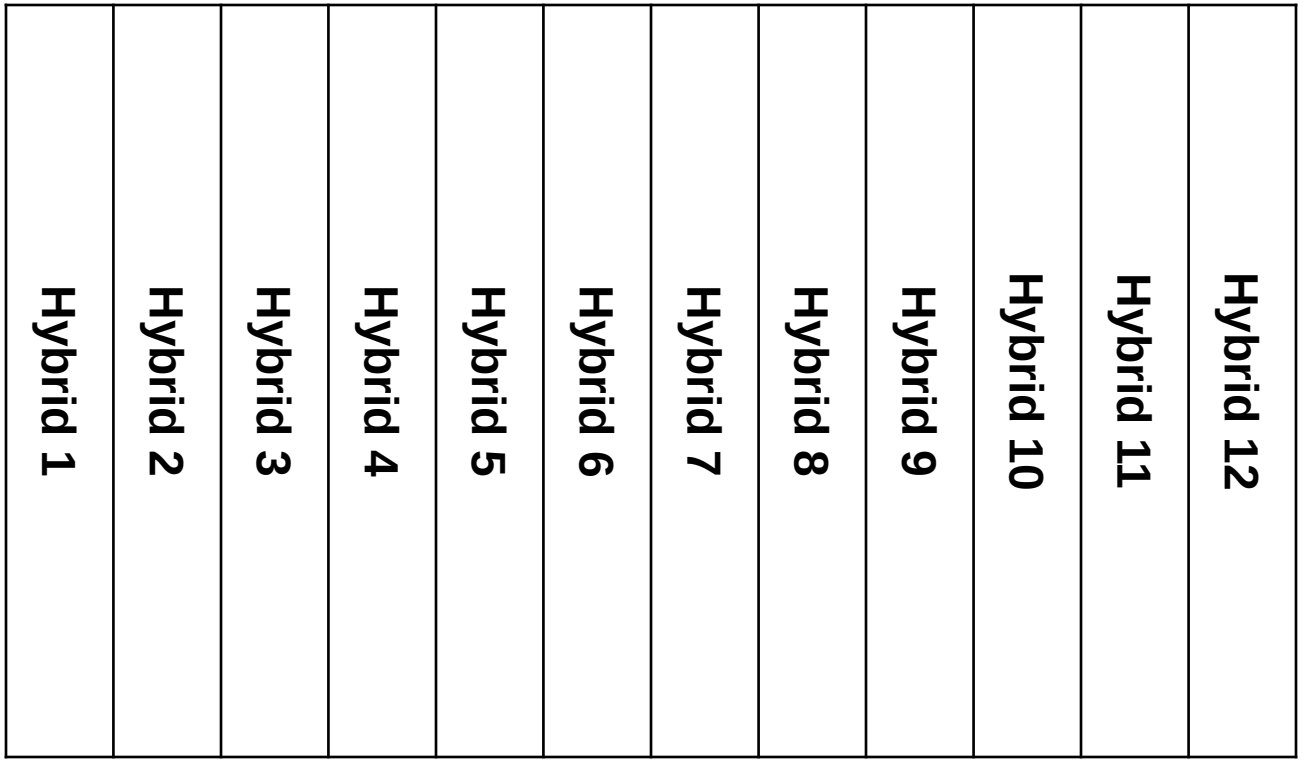
Strip Plots, No Replication

- Examines each hybrid once in the field.
- No check-strip, no replication.
- Seed companies often use these strip plots for farmer demonstration plots.
- However, most seed companies will have the same comparisons on many farms across the region.

Strip Plots, No Replication

- Seed companies will average all of the data together across the region to make conclusions.
- Data from a single location is not examined by itself.
  - No way to separate noise from hybrid performance.

Strip Plots



Strip Plots

- **Advantages:**
- Strip plots are the easiest plots to establish at one location. Multiple hybrids can be added to the end of a trial. Many hybrids can be evaluated. These plots are suited to farm-scale equipment.

Strip Plots

- **Disadvantages:**
- Strip plots at one location should never be used for conclusions by themselves.
- The same comparisons should be made at several locations across the region before any conclusions are made.

Corn Harvest