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Getting to Know Your Yield Response Better through Whole-field Randomized Experiments

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Market Report	Year Ago	4 Wks Ago	4/17/17
Livestock and Products, Weekly Average			
Nebraska Slaughter Steers, 35-65% Choice, Live Weight.	135.51	129.50	124.27
Nebraska Feeder Steers, Med. & Large Frame, 550-600 lb.	185.48	164.77	181.17
Nebraska Feeder Steers, Med. & Large Frame 750-800 lb.	158.53	137.92	143.54
Choice Boxed Beef, 600-750 lb. Carcass.	221.51	221.56	209.94
Western Corn Belt Base Hog Price Carcass, Negotiated	63.18	66.71	55.99
Pork Carcass Cutout, 185 lb. Carcass 51-52% Lean.	77.29	81.26	74.42
Slaughter Lambs, wooled and shorn, 135-165 lb. National.	132.20	139.73	151.02
National Carcass Lamb Cutout FOB.	342.10	326.26	354.50
Crops, Daily Spot Prices			
Wheat, No. 1, H.W. Imperial, bu.	3.73	3.10	2.88
Corn, No. 2, Yellow **Columbus**, bu.	3.53	3.22	3.32
Soybeans, No. 1, Yellow **Columbus,** bu.	8.91	9.00	8.62
Grain Sorghum, No.2, Yellow Dorchester, cwt.	5.51	4.97	5.26
Oats, No. 2, Heavy Minneapolis, Mn, bu.	2.46	2.86	2.82
Feed			
Alfalfa, Large Square Bales, Good to Premium, RFV 160-185 Northeast Nebraska, ton.	*	133.75	123.75
Alfalfa, Large Rounds, Good Platte Valley, ton.	80.00	67.50	67.50
Grass Hay, Large Rounds, Good Nebraska, ton.	85.00	65.00	65.00
Dried Distillers Grains, 10% Moisture Nebraska Average.	125.00	96.00	105.00
Wet Distillers Grains, 65-70% Moisture Nebraska Average.	48.00	40.77	40.50
* No Market			

Six researchers at the University of Nebraska-Lincoln are working on the USDA-NIFA-funded Data Intensive Farm Management (DIFM) project. DIFM is based at the University of Illinois, and also involves the Universities of Kentucky, Massachusetts, Maryland, and Illinois State. The overarching goal of the project is to collect production data after conducting large-scale, on-farm randomized input use field trials, and then using the information to inform growers of optimal input use practices to enhance their profits. DIFM researchers hope to find a *win-win* situation in which more efficient crop nutrient management both increases farm profits and water quality in the Mississippi River basin.

Figures 1a and 1b show an example randomized experiment design on nitrogen (up) and seed rates (down).

Figure 1a.

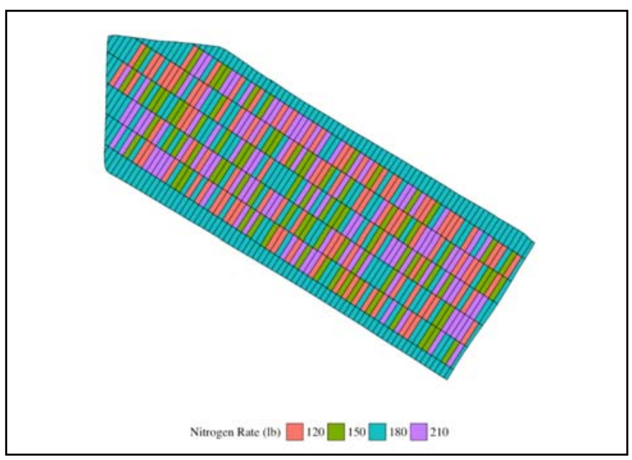
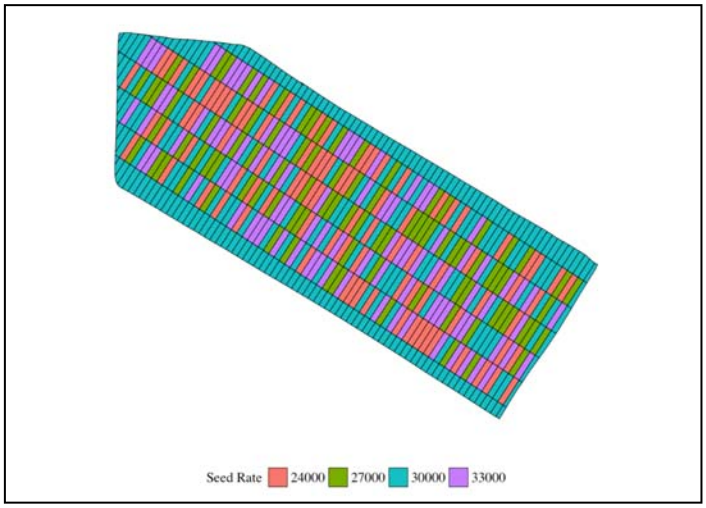


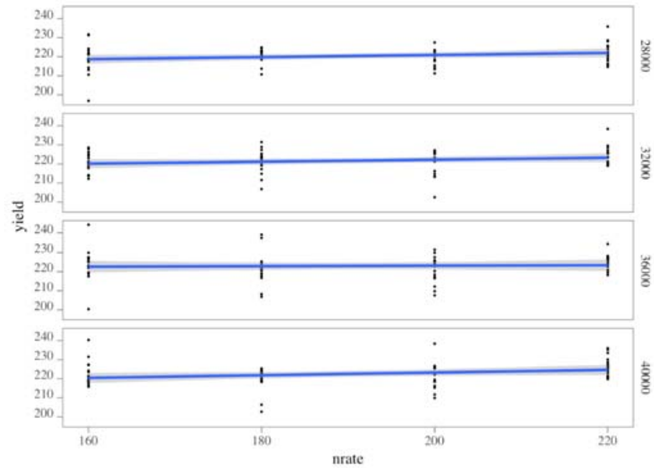
Figure 1b.



In this example, the Kentucky field is 180 acres in size, and its field trial includes 380, 60 ft. x 280 ft. plots. Each plot is randomly assigned 1 of the 16 treatment types which consist of the complete pair of nitrogen rates (120, 150, 180, and 210 lbs./acre) and seed rates (24,000, 27,000, 30,000, and 33,000). One of the pairs is the nitrogen and seed rates that the growers would have chosen for the entire field if not participating in the randomized experiment. Once the experiment design is determined, the Geographic Information System (GIS) files are sent to the growers, and they then use variable-rate input application machinery to apply nitrogen and seed according to the design. (Literally, the grower simply drives the machinery in the usual fashion, and the GIS-based system puts the trial "into the ground" with almost no extra effort from the grower.) Then, after using precision-technology yield monitors to measure the harvest in each experimental plot, the grower returns the GIS yield data to DIFM researchers. With the nitrogen and seed rates application maps and yield data as well as maps of measured field characteristics and data from recorded weather measurement, the DIFM researchers have available the key components necessary to conduct statistical analysis that improves our understanding of how yield responds to managed farm inputs, field characteristics, and weather.

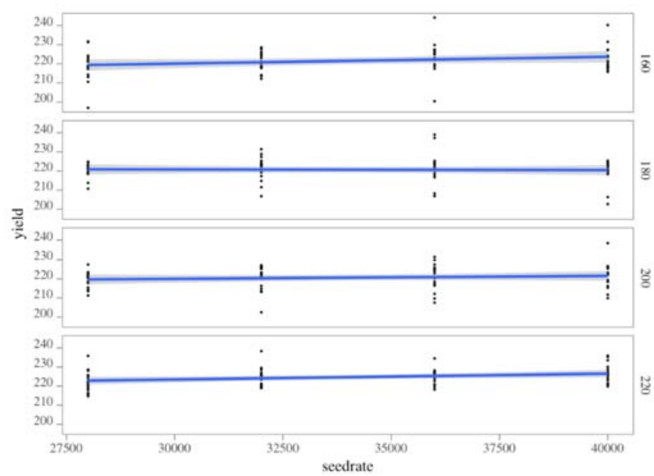
In 2016, DIFM conducted five experiments in Illinois and two experiments in Nebraska. In 2017, DIFM is currently conducting 45 experiments on farm fields in 5 states and Argentina. We will present visualizations of yield response to nitrogen and seed rates for one of the fields. In Figure 2 there are four panels, with each panel showing how yield responded to nitrogen rates given the seed rates. For example, the first panel shows how yield responded to nitrogen when the seed rate is 28,000. Note, that at any level of seed rate, increasing the nitrogen fertilizer application rate enhanced yield very little.

Figure 2.



Similarly, Figure 3 shows how yield responded to seed rates for four different given nitrogen rates. Just like the nitrogen case, at any level of nitrogen rate, increasing the seed rate increased yield very little.

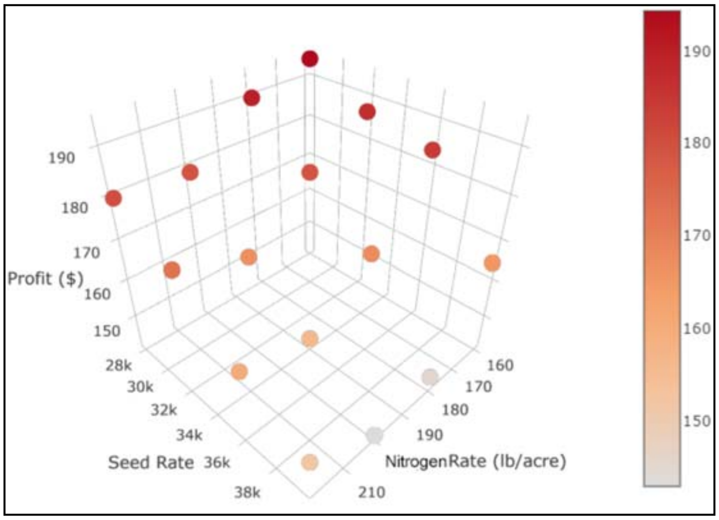
Figure 3.



Figures 2 and 3 suggest what kind of information we are obtaining from the randomized experiments, and also how that data can be. Suppose the corn price is $3.50/bu., nitrogen price is $0.46/lb., the seed price is $0.00351/seed, and all the other costs are fixed at $400/acre. Under these circumstances, the expected profitability of each treatment pair is presented in Figure 4.

The figure shows that, for this particular field and given a particular set of weather events, increasing the nitrogen application rate reduced profits. Because nitrogen and seed rates have little effect on the yield level, this result is quite intuitive. Note that the grower, if not participating in the experiment, would have chosen to apply 200 lbs./acre of nitrogen fertilizer and sow 36,000 seeds per acre. If he instead would have picked the most profitable management strategy, 160 lbs./acre of nitrogen and 28,000 seeds/acre, he would have earned $35 more per acre, or almost $3,000 on a typical 8-acre field.

Figure 4.



Our conclusion that the grower would have increased profits by reducing his applied nitrogen fertilizer application rate has important environmental implications. Growers are coming under increasing pressure to reduce nitrogen fertilizer loss into the Mississippi River basin's waterways, which has been a major contributor to environmental degradation, including the Gulf of Mexico's infamous hypoxic "Dead Zone." Our analysis suggests that there may be many opportunities for farm income/environmental win-win changes in farm fertilizer management strategies.

At this point, it is premature to say that following the results of this one randomized experiment would increase the grower's annual per-acre income by $35. Yield response to nitrogen fertilizer and seed application rates varies year by year according to weather events. The DIFM has funding for three more years of on-farm field experiments and has plans to seek further funding to increase the scope of its trials from a few dozen to many hundreds of field trials per year. Moving forward, our hope is to take into account the impacts of weather on yield response to nitrogen and seed rates in determining the profit maximizing input use practice.

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