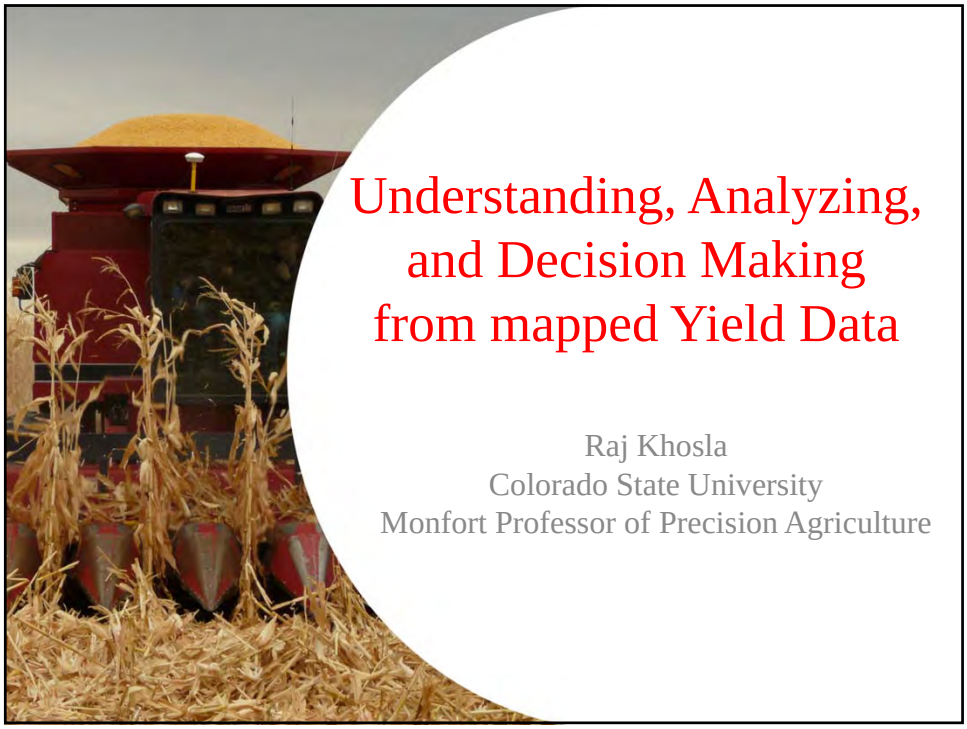
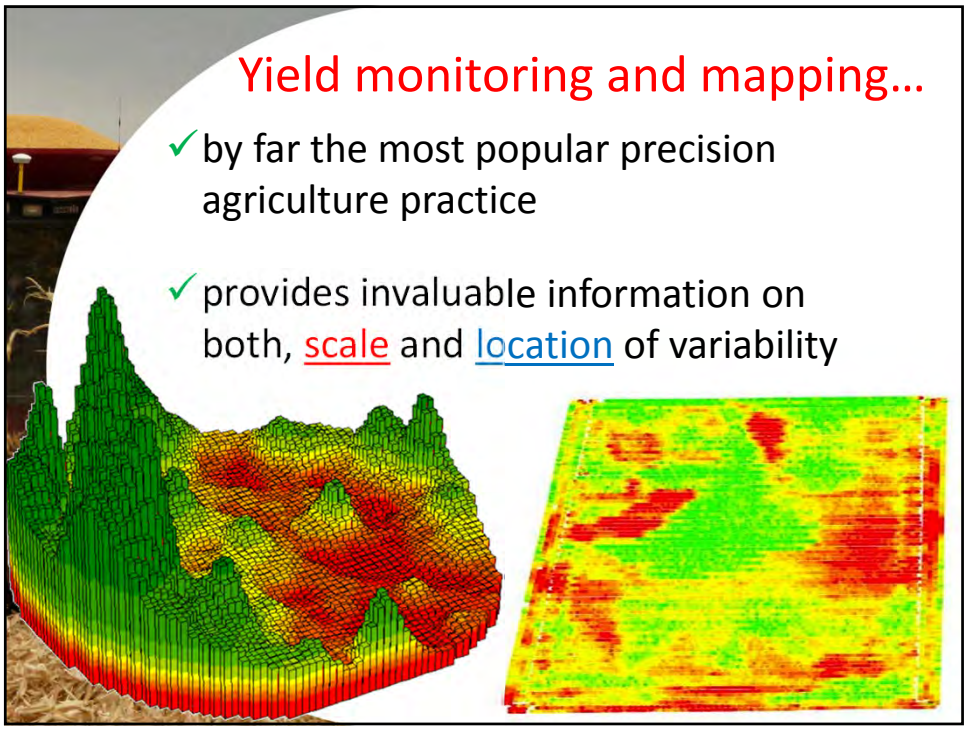


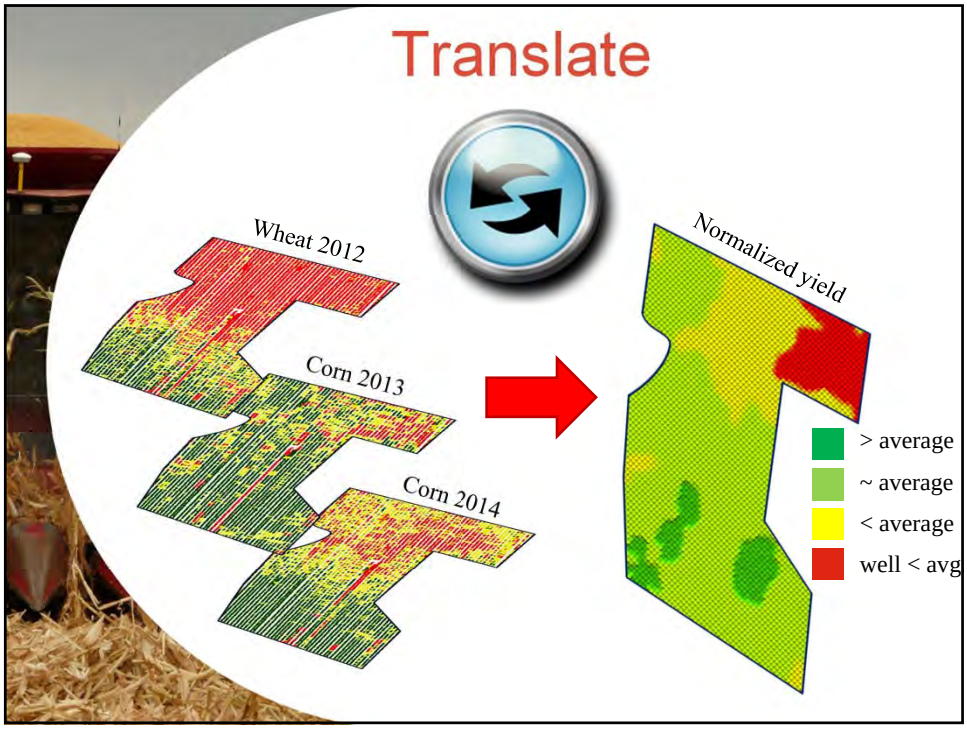
Understanding, Analyzing, and Decision Making from mapped Yield Data

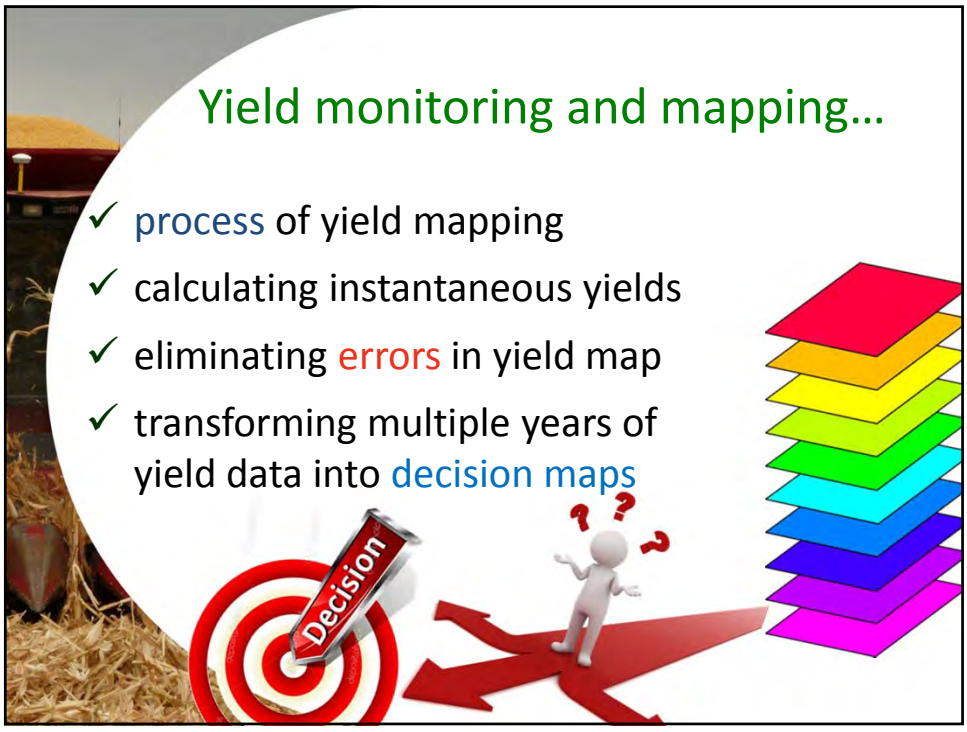
Raj Khosla
Colorado State University
Monfort Professor of Precision Agriculture



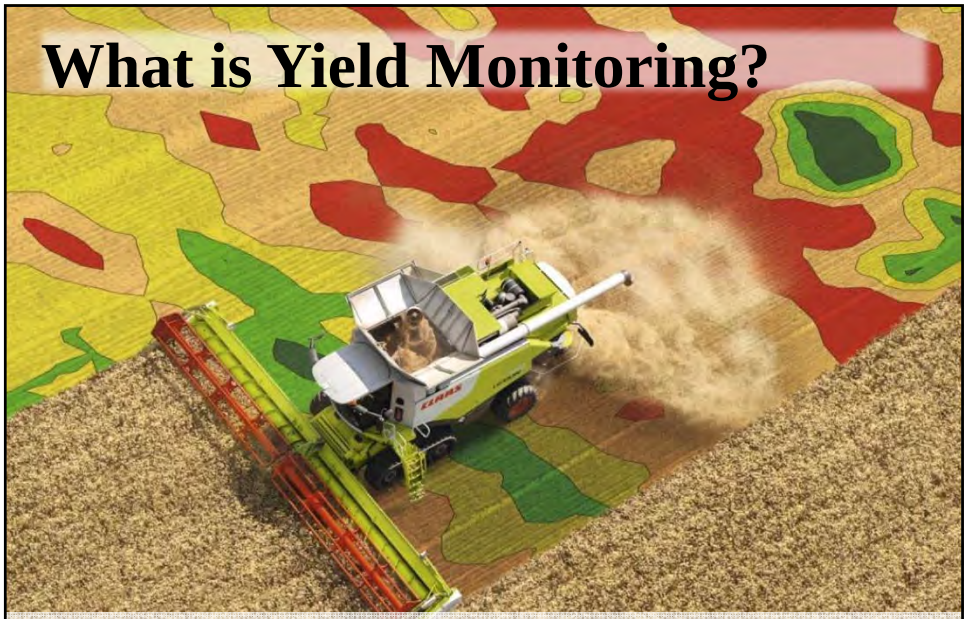
Yield monitoring and mapping…

- ✓ by far the most popular precision agriculture practice
- ✓ provides invaluable information on both, scale and location of variability

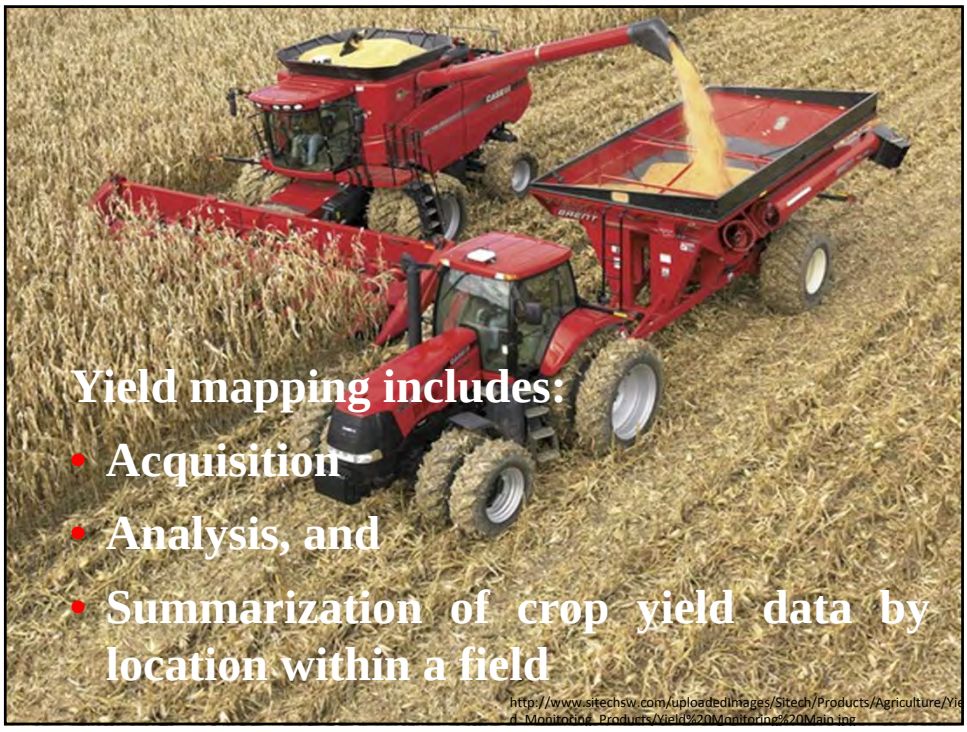

Translate
Wheat 2012
Corn 2013
Corn 2014
Normalized yield
> average
~ average
< average
well < avg


Yield monitoring and mapping…
✓ process of yield mapping
✓ calculating instantaneous yields
✓ eliminating errors in yield map
✓ transforming multiple years of yield data into decision maps
Decision

What is Yield Monitoring?



- Process of measuring and mapping yield in real time
- Quantifies spatial and temporal variability in soil and crop properties



Yield mapping includes:

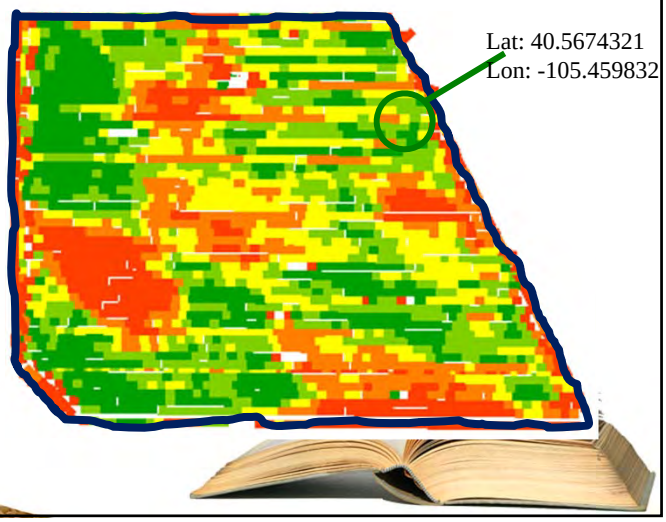
- **Acquisition**
- **Analysis, and**
- **Summarization of crop yield data by location within a field**

http://www.sitechsw.com/uploadedImages/Sitech/Products/Agriculture/Yield_Monitoring_Products/Yield%20Monitoring%20Main.jpg

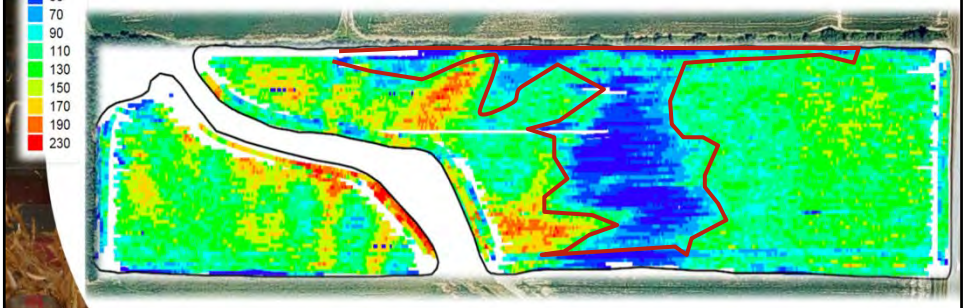
Definition of yield map

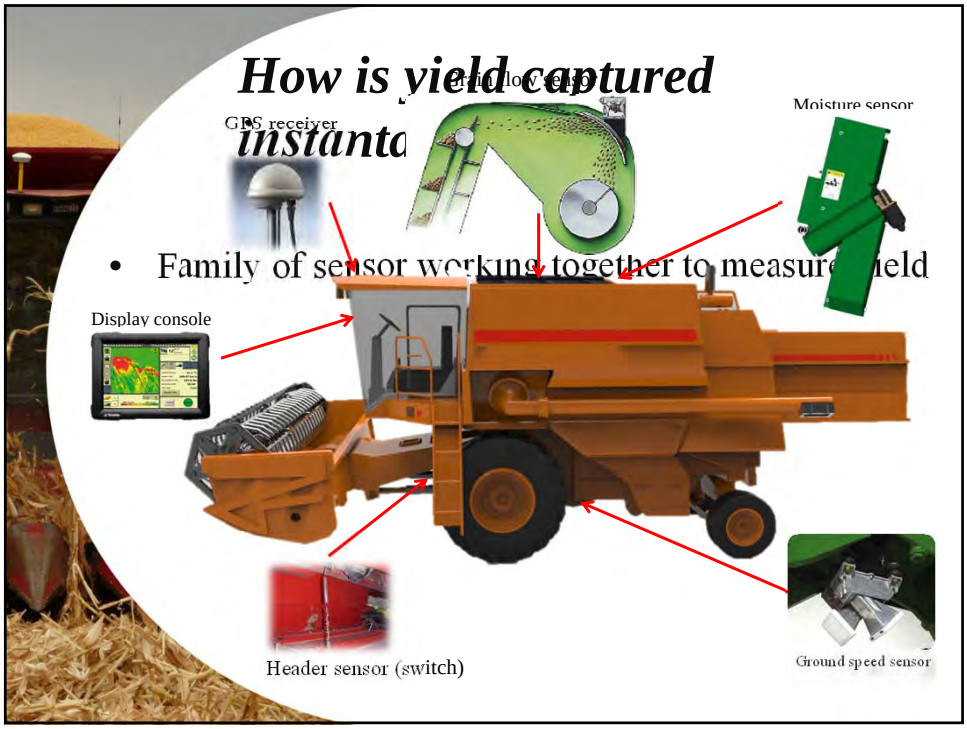
A yield map is a spatially referenced, graphical representation of crop yield for a defined area.

Final product is usually a tonal or colored map displaying ranges of yield within a field.

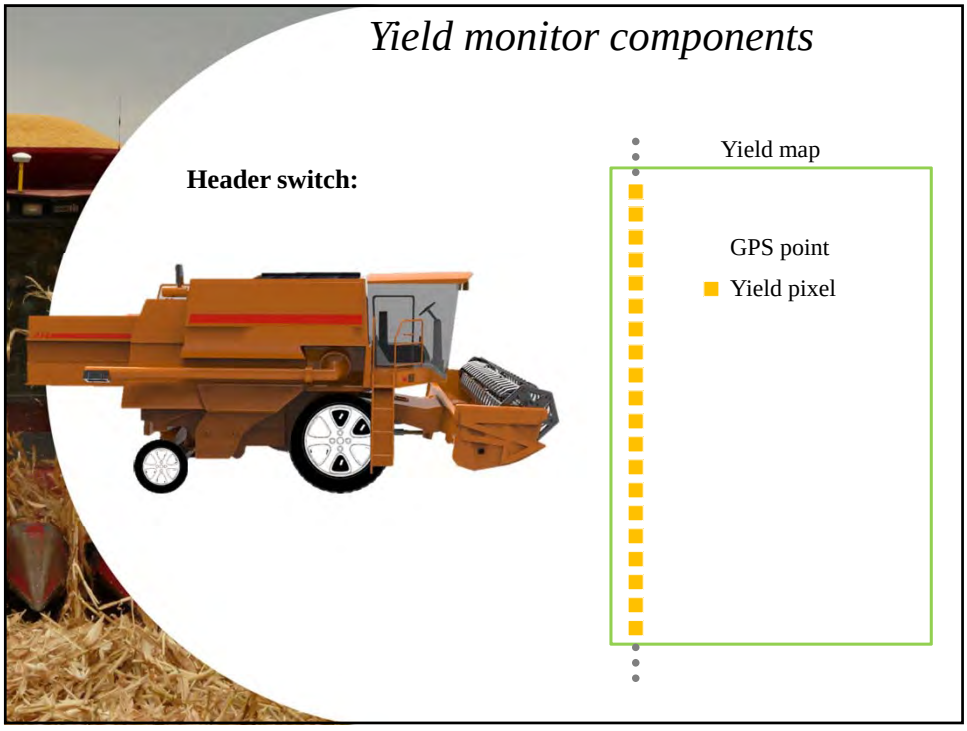


Yield monitors provide a way to quantify yield variations that producers know exist





- Family of sensor working together to measure yield



Yield monitor components

Ground Speed Sensor:

Combine speedometer

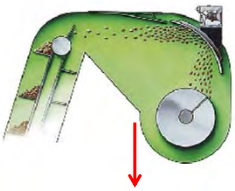
Ground speed sensor

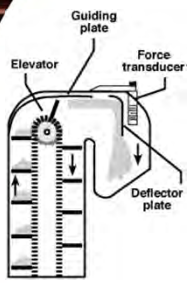
10 km/h

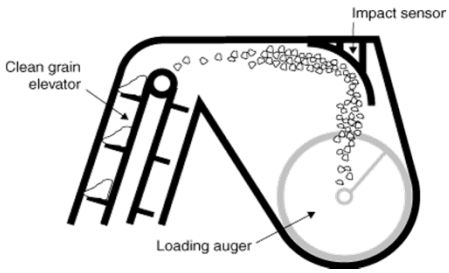
In slippery terrain

An ultrasonic ground speed sensor

Grain flow sensor

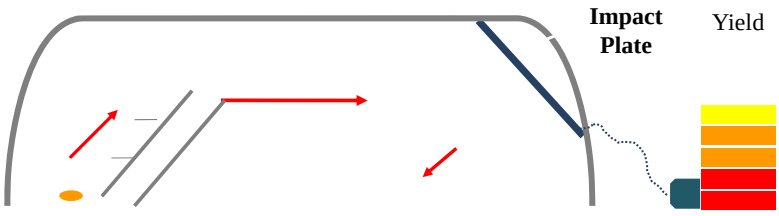






Impact Force Sensor:

Grain flow is measured by quantifying the amount of force applied when the grain strikes on a spring-loaded impact plate.



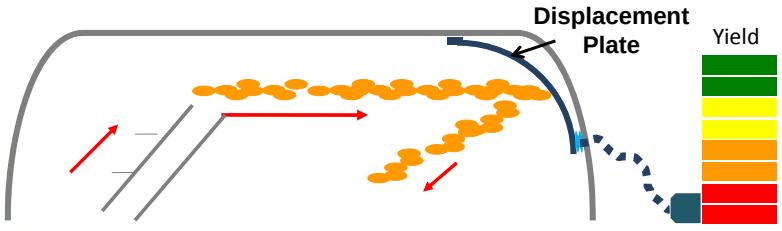
Force is measured by a load cell that converts load into electrical signal.

A very light impact on the plate causes a measurable change in the resistance of the electrical current flow

Change in electrical flow is proportional to amount grain flow

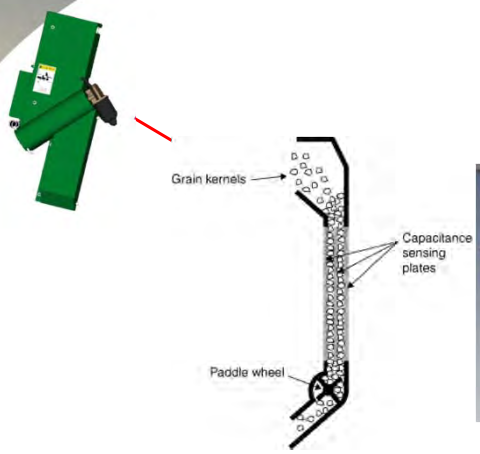
Plate Displacement Sensor:

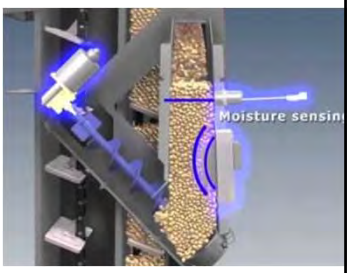
- Similar to impact force sensor.
- Measure displacement of plate and not **force**.
- Grain flow is measured by quantifying the displacement of the plate when the grain strikes on a spring-loaded impact plate.



https://en.wikipedia.org/wiki/File:GrainMassFlowSensorVideo.webm

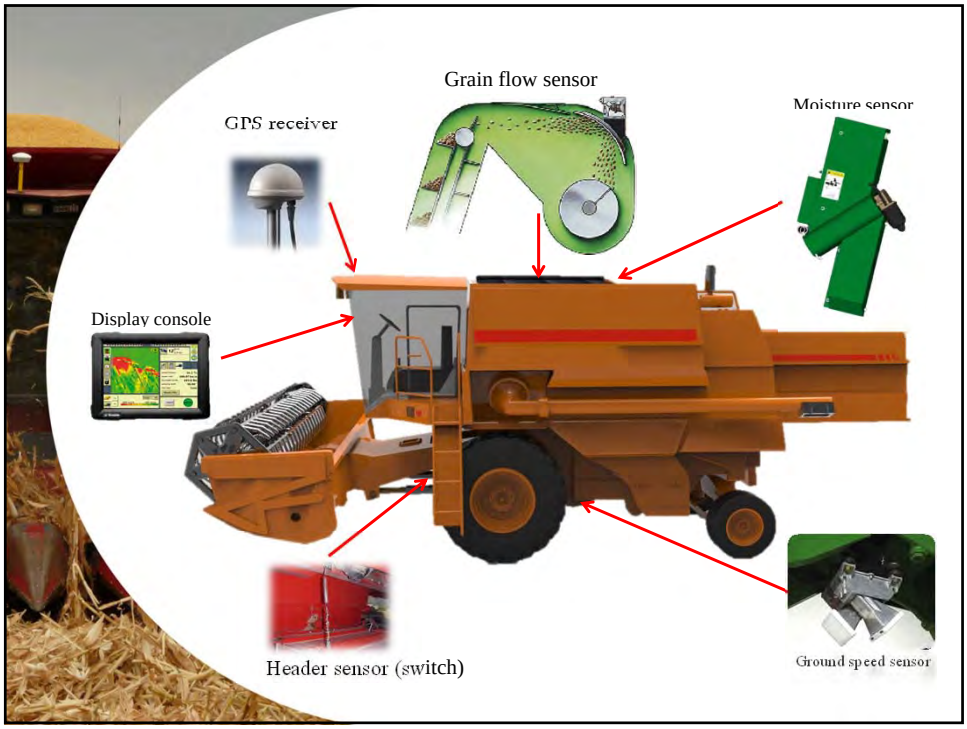
Moisture sensor

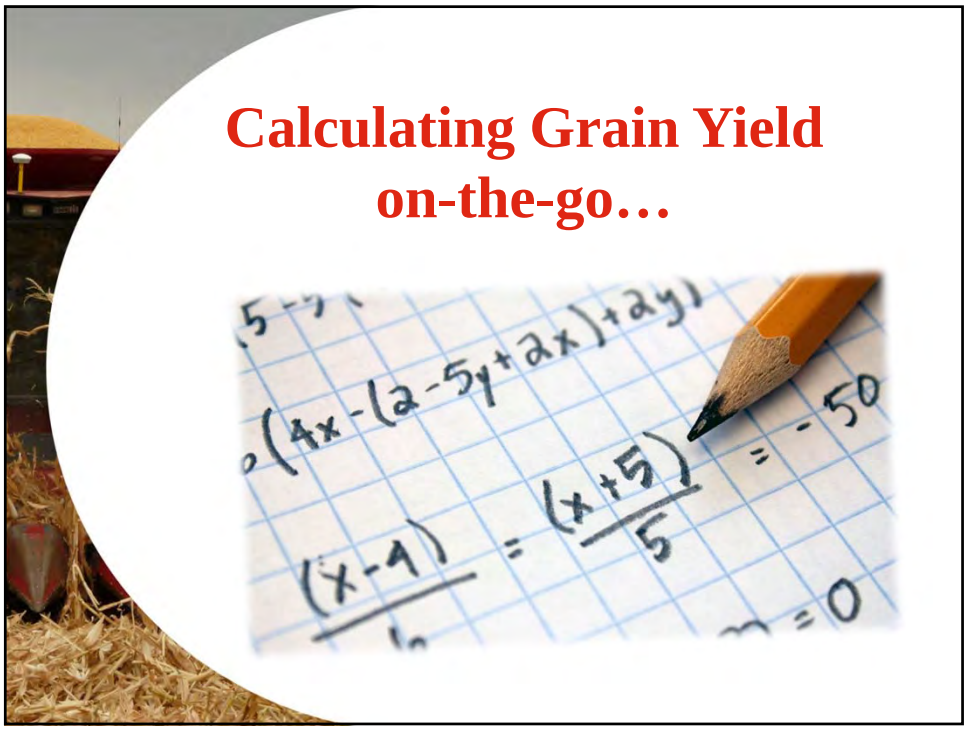




It is a Capacitance type sensor, works on the principle of measuring **di-electric** property of a substance (Grain).

Di-electric constant of water = 78
soil ~ 4
vacuum ~ 1

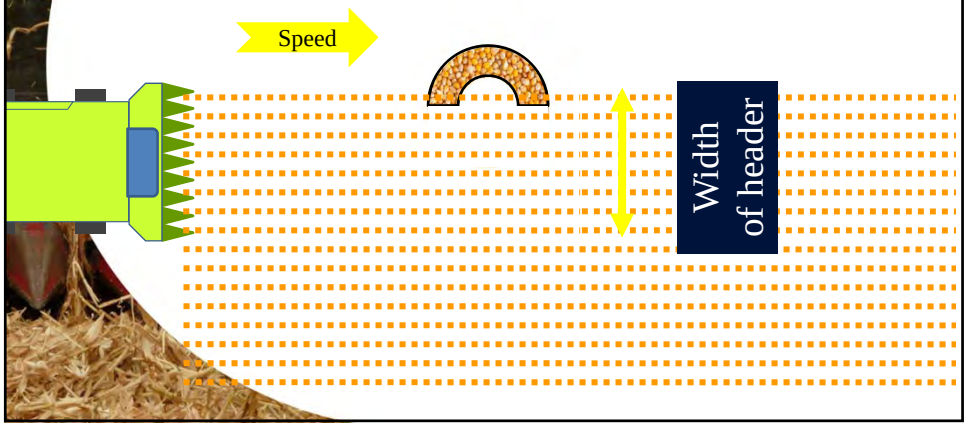

Grain flow sensor
GPS receiver
Moisture sensor
Display console
Header sensor (switch)
Ground speed sensor


Calculating Grain Yield
on-the-go…

Calculating grain yield on-the-go…

To determine instantaneous crop yield need 3 pieces of information:

1. Grain flow rate (lbs/sec)
2. Combine's travel speed (ft/sec)
3. ·Cutting width of header (ft)



Calculating grain yield on-the-go…

Calculate instantaneous grain yield of a combine with an 8-row corn header harvesting at a speed of 5 miles per hour. The corn row width is 30" and the grain flow sensor recorded a flow rate of 44 lbs/sec for the previous second.

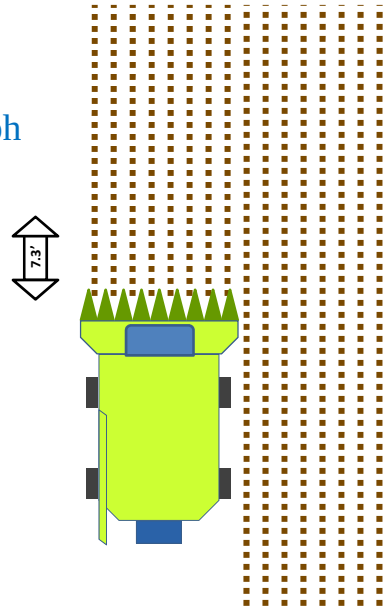
Recall:
1mile = 5280 ft
1 hr = 3600 sec
1 acre = 43560 ft

Calculating grain yield on-the-go…

1) Area harvested

Combine is moving at 5 mph

$$\frac{5\ \cancel{miles}}{1\ \cancel{hour}} \times \frac{1\ \cancel{hour}}{3600\ sec} \times \frac{5280\ ft}{1\ \cancel{mile}} \quad 7.3\ ft$$



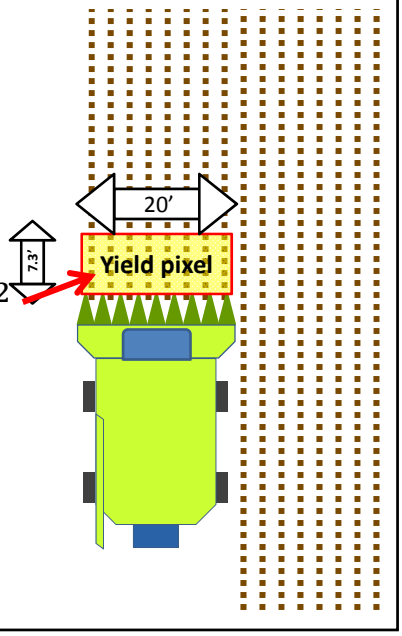
Calculating grain yield on-the-go…

1) Area harvested

Combine has 8 rows of 30''

$$8\ \cancel{row} \times \frac{30\ \cancel{in}}{\cancel{row}} \times \frac{1\ ft}{12\ \cancel{in}} \quad 20\ ft$$

$$7.3\ ft \times 20\ ft = 146\ ft^2$$



2) Volume harvested in bushels

Grain flow sensor recorded a flow rate of 44 lbs/sec.

$$\frac{44\ lbs}{1\ sec} \times \frac{1\ bu}{56\ lbs} = \frac{0.786\ bu}{sec}$$

3) Measure yield in bu/A

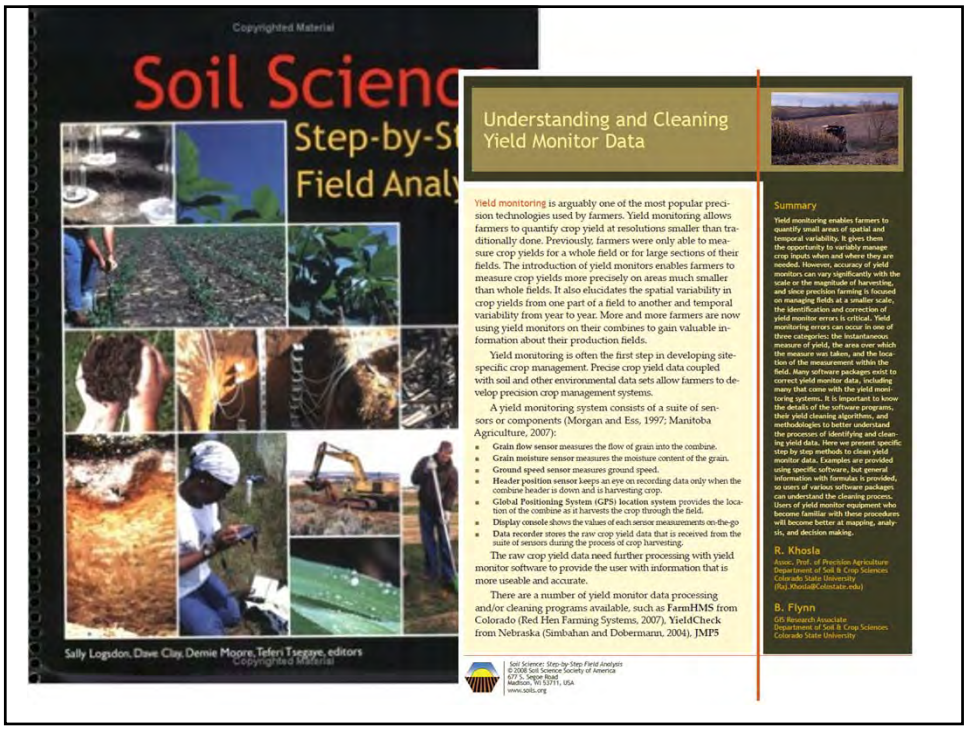
$$\frac{0.786\ bu}{sec} \times \frac{1\ sec}{146\ ft^2} \times \frac{43{,}560\ ft^2}{1\ ac} = \boxed{\frac{234\ bu}{ac}}$$

146 ft² in 1 sec

Yield pixel

0.786 bu in 1 sec


Cleaning yield data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Step-by-S
Field Analy
Sally Logsdon, Dave Clay, Dennie Moore, Teferi Tsegaye, editors
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Understanding and Cleaning Yield Monitor Data
Yield monitoring is arguably one of the most popular precision technologies used by farmers. Yield monitoring allows farmers to quantify crop yield at resolutions smaller than traditionally done. Previously, farmers were only able to measure crop yields for a whole field or for large sections of their fields. The introduction of yield monitors enables farmers to measure crop yields more precisely on areas much smaller than whole fields. It also elucidates the spatial variability in crop yields from one part of a field to another and temporal variability from year to year. More and more farmers are now using yield monitors on their combines to gain valuable information about their production fields.
Yield monitoring is often the first step in developing site-specific crop management. Precise crop yield data coupled with soil and other environmental data sets allow farmers to develop precision crop management systems.
A yield monitoring system consists of a suite of sensors or components (Morgan and Ess, 1997; Manitoba Agriculture, 2007):
Grain flow sensor measures the flow of grain into the combine.
Grain moisture sensor measures the moisture content of the grain.
Ground speed sensor measures ground speed.
Header position sensor keeps an eye on recording data only when the combine header is down and is harvesting crop.
Global Positioning System (GPS) location system provides the location of the combine as it harvests the crop through the field.
Display console shows the values of each sensor measurements on-the-go
Data recorder stores the raw crop yield data that is received from the suite of sensors during the process of crop harvesting.
The raw crop yield data need further processing with yield monitor software to provide the user with information that is more useable and accurate.
There are a number of yield monitor data processing and/or cleaning programs available, such as FarmHMS from Colorado (Red Hen Farming Systems, 2007), YieldCheck from Nebraska (Simbahan and Dobermann, 2004), JMP5
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Madison, WI 53711, USA
www.soils.org
Summary
Yield monitoring enables farmers to quantify small areas of spatial and temporal variability. It gives them the opportunity to variably manage crop inputs when and where they are needed. However, accuracy of yield monitors can vary significantly with the scale or the magnitude of harvesting, and since precision farming is focused on managing fields at a smaller scale, the identification and correction of yield monitor errors is critical. Yield monitoring errors can occur in one of three categories: the instantaneous measure of yield, the area over which the measure was taken, and the location of the measurement within the field. Many software packages exist to correct yield monitor data, including many that come with the yield monitoring systems. It is important to know the details of the software programs, their yield cleaning algorithms, and methodologies to better understand the processes of identifying and cleaning yield data. Here we present specific step by step methods to clean yield monitor data. Examples are provided using specific software, but general information with formulas is provided, so users of various software packages can understand the cleaning process. Users of yield monitor equipment who become familiar with these procedures will become better at mapping, analysis, and decision making.
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B. Flynn
GIS Research Associate
Department of Soil & Crop Sciences
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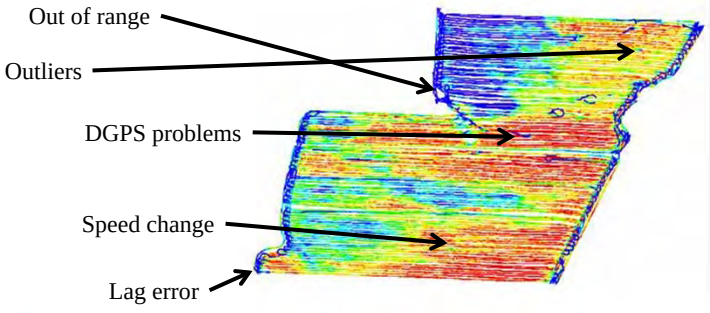
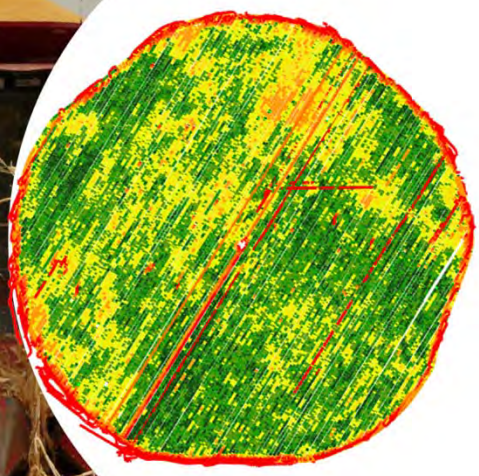
Cleaning yield data

Raw yield map contains several data points with eroneous yield information.



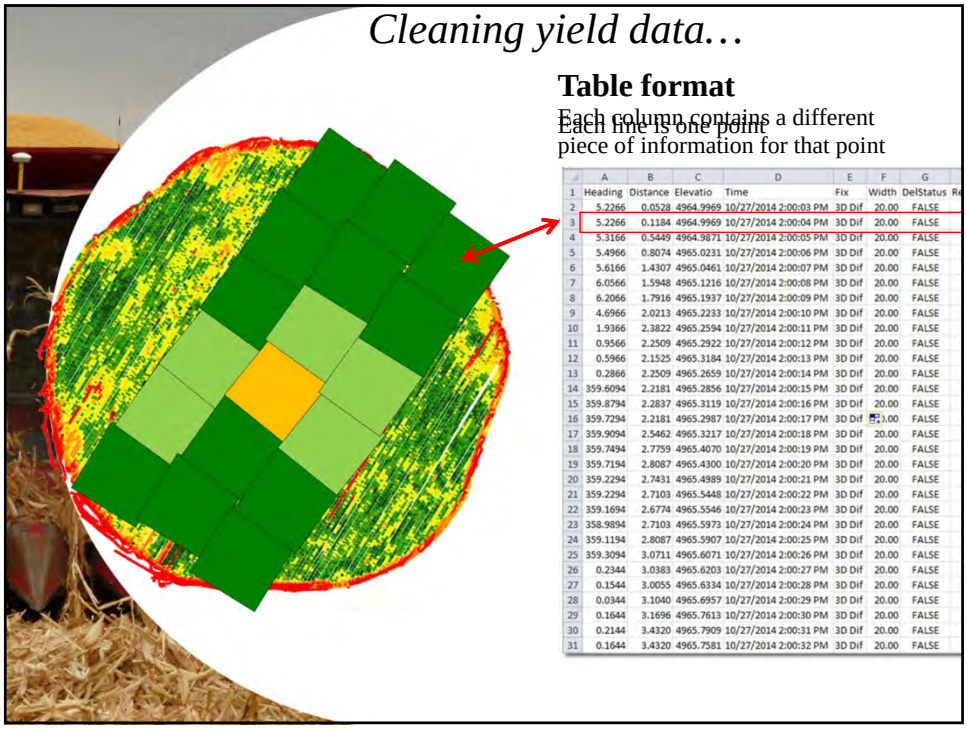
Raw yield map needs to be cleaned

Cleaning yield data…



The **raw crop yield data** need further **processing** to provide the user with information that is more

- ✓ **useable**
- ✓ **accurate**.



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8	6.2066	1.7916	4965.1937	10/27/2014 2:00:09 PM	3D Dif	20.00	FALSE
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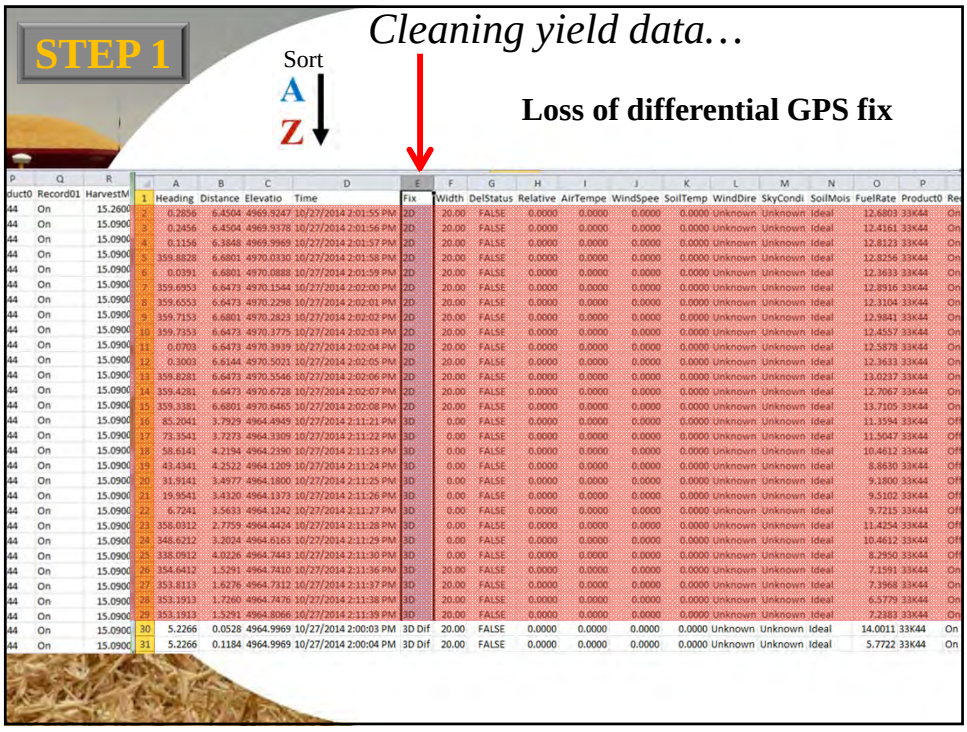

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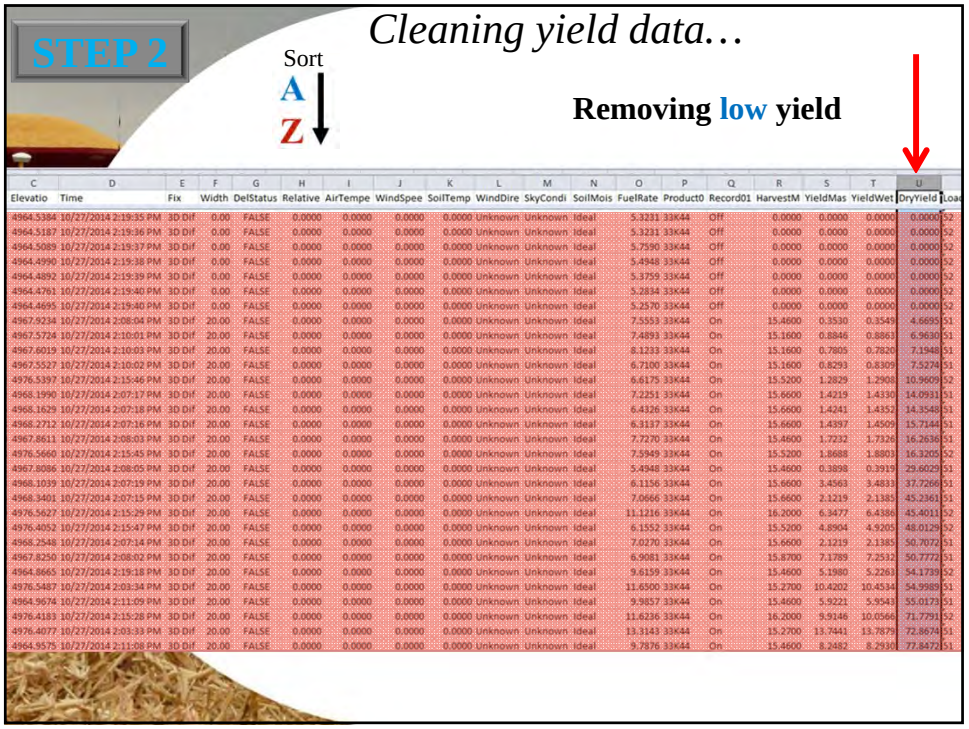
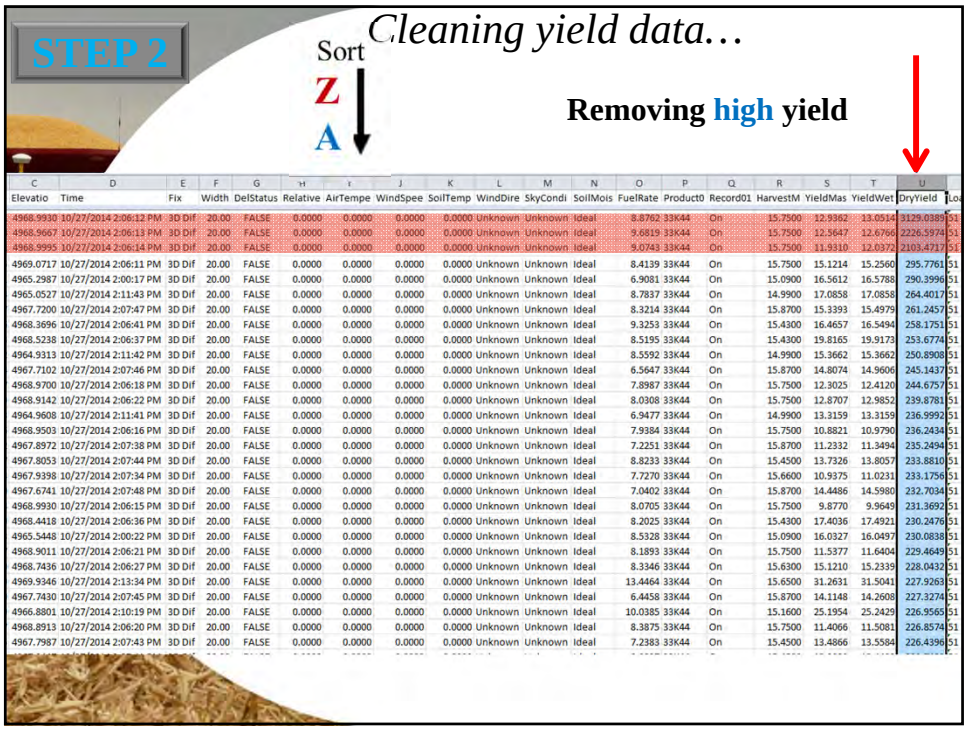
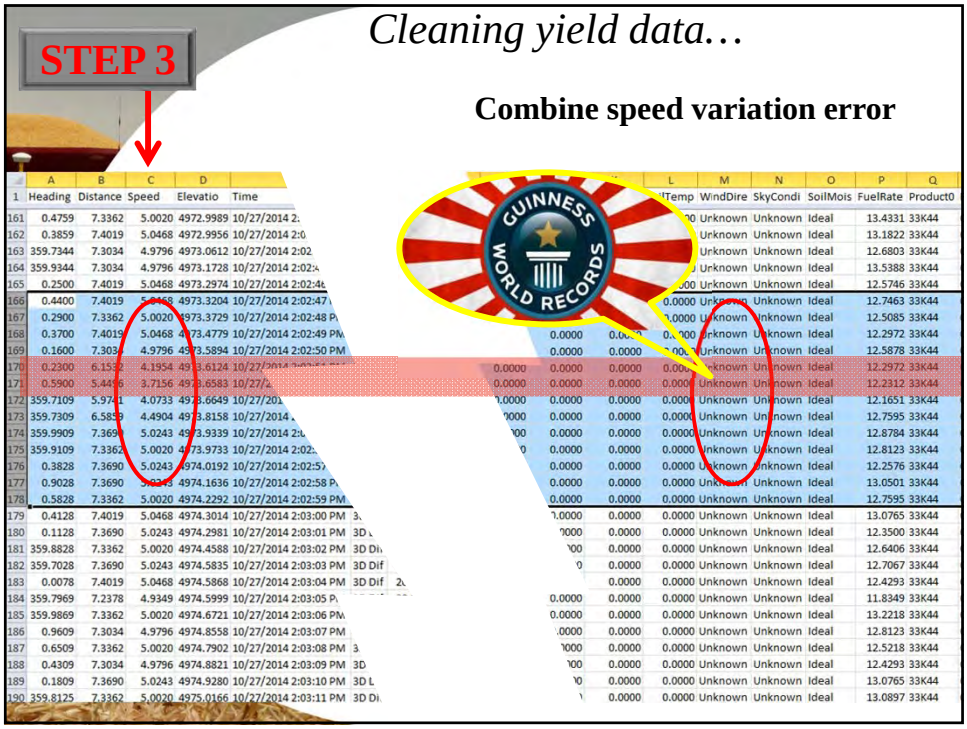
17	73.3541	3.7273	4964.3309	10/27/2014 2:11:22 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	11.5047	33K44
18	58.6141	4.2194	4964.2390	10/27/2014 2:11:23 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	10.4612	33K44
19	43.4341	4.2522	4964.1209	10/27/2014 2:11:24 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.8630	33K44
20	31.9141	3.4977	4964.1800	10/27/2014 2:11:25 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.1800	33K44
21	19.9541	3.4320	4964.1373	10/27/2014 2:11:26 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.5102	33K44
22	6.7241	3.5633	4964.1242	10/27/2014 2:11:27 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.7215	33K44
23	358.0312	2.7759	4964.4424	10/27/2014 2:11:28 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	11.4254	33K44
24	348.6212	3.2024	4964.6163	10/27/2014 2:11:29 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	10.4612	33K44
25	338.0912	4.0226	4964.7443	10/27/2014 2:11:30 PM	3D	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.2950	33K44
26	354.6412	1.5291	4964.7410	10/27/2014 2:11:36 PM	3D	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.1591	33K44
27	353.8113	1.6276	4964.7312	10/27/2014 2:11:37 PM	3D	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.3968	33K44
28	353.1913	1.7260	4964.7476	10/27/2014 2:11:38 PM	3D	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.5779	33K44
29	353.1913	1.5291	4964.8066	10/27/2014 2:11:39 PM	3D	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.2383	33K44
30	5.2266	0.0528	4964.9969	10/27/2014 2:00:03 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	14.0011	33K44
31	5.2266	0.1184	4964.9969	10/27/2014 2:00:04 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.7722	33K44

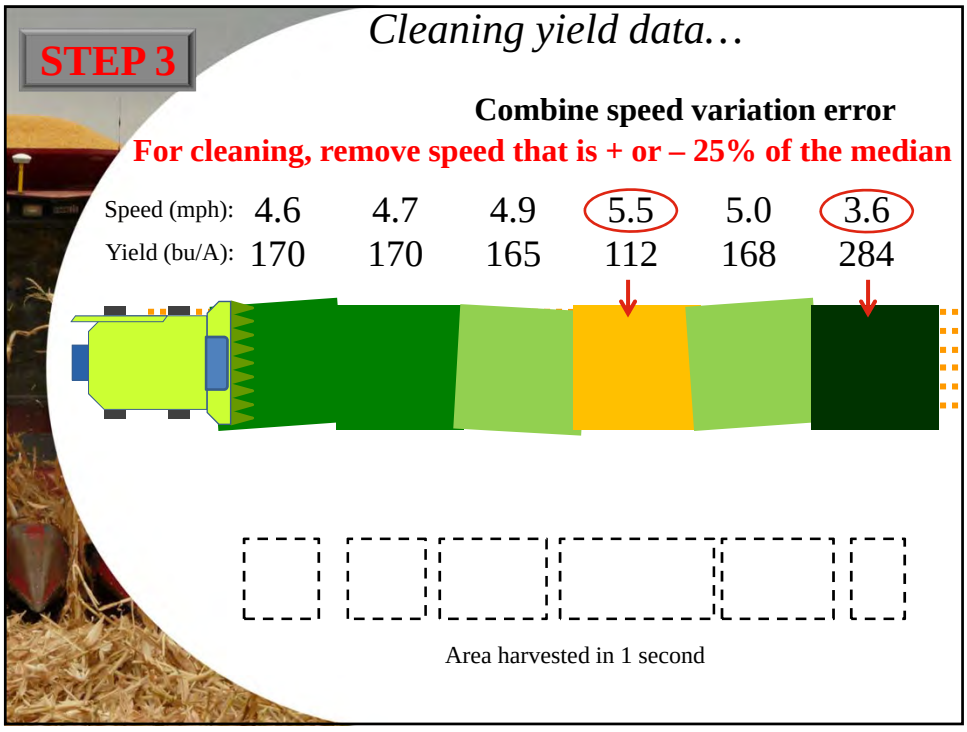


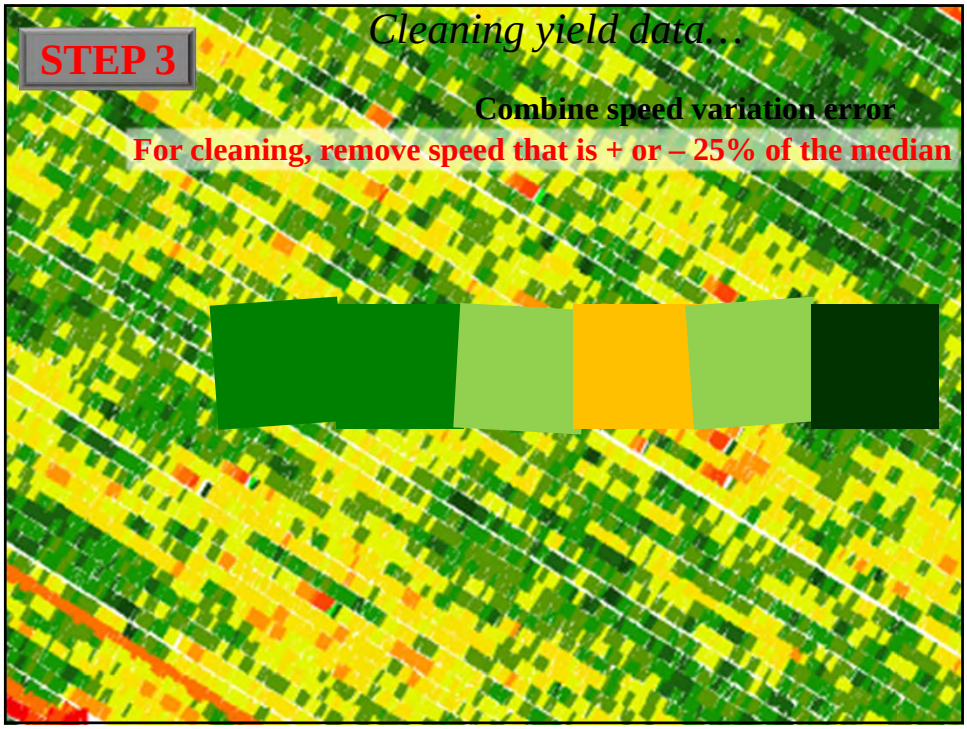
Elevatio	Time	Fix	Width	DelStatus	Relative	AirTempe	WindSpee	SoilTemp	WindDire	SkyCondi	SoilMois	FuelRate	Product0	Record01	HarvestM	YieldMas	YieldWet	DryYield	Loa
4964.5384	10/27/2014 2:19:35 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.3231	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4964.5187	10/27/2014 2:19:36 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.3231	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4964.5089	10/27/2014 2:19:37 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.7590	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4964.4990	10/27/2014 2:19:38 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.4948	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4964.4892	10/27/2014 2:19:39 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.3759	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4964.4761	10/27/2014 2:19:40 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.2834	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4964.4695	10/27/2014 2:19:40 PM	3D Dif	0.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.2570	33K44	Off	0.0000	0.0000	0.0000	0.0000	52
4967.9234	10/27/2014 2:08:04 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.5553	33K44	On	15.4600	0.3530	0.3549	4.6695	51
4967.5724	10/27/2014 2:10:01 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.4893	33K44	On	15.1600	0.8846	0.8863	6.9630	51
4967.6019	10/27/2014 2:10:03 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.1233	33K44	On	15.1600	0.7805	0.7820	7.1948	51
4967.5527	10/27/2014 2:10:02 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.7100	33K44	On	15.1600	0.8293	0.8309	7.5274	51
4976.5397	10/27/2014 2:15:46 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.6175	33K44	On	15.5200	1.2829	1.2908	10.9609	52
4968.1990	10/27/2014 2:07:17 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.2251	33K44	On	15.6600	1.4219	1.4330	14.0931	51
4968.1629	10/27/2014 2:07:18 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.4326	33K44	On	15.6600	1.4241	1.4352	14.3548	51
4968.2712	10/27/2014 2:07:16 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.3137	33K44	On	15.6600	1.4397	1.4509	15.7144	51
4967.8611	10/27/2014 2:08:03 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.7270	33K44	On	15.4600	1.7232	1.7326	16.2636	51
4976.5660	10/27/2014 2:15:45 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.5949	33K44	On	15.5200	1.8688	1.8803	16.3205	52
4967.8086	10/27/2014 2:08:05 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	5.4948	33K44	On	15.4600	0.3898	0.3919	29.6029	51
4968.1039	10/27/2014 2:07:19 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.1156	33K44	On	15.6600	3.4563	3.4833	37.7266	51
4968.3401	10/27/2014 2:07:15 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.0666	33K44	On	15.6600	2.1219	2.1385	45.2361	51
4976.5627	10/27/2014 2:15:29 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	11.1216	33K44	On	16.2000	6.3477	6.4386	45.4011	52
4976.4052	10/27/2014 2:15:47 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.1552	33K44	On	15.5200	4.8904	4.9205	48.0129	52
4968.2548	10/27/2014 2:07:14 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.0270	33K44	On	15.6600	2.1219	2.1385	50.7072	51
4967.8250	10/27/2014 2:08:02 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.9081	33K44	On	15.8700	7.1789	7.2532	50.7772	51
4964.8665	10/27/2014 2:19:18 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.6159	33K44	On	15.4600	5.1980	5.2263	54.1739	52
4976.5487	10/27/2014 2:03:34 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	11.6500	33K44	On	15.2700	10.4202	10.4534	54.9989	51
4964.9674	10/27/2014 2:11:09 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.9857	33K44	On	15.4600	5.9221	5.9543	55.0173	51
4976.4183	10/27/2014 2:15:28 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	11.6236	33K44	On	16.2000	9.9146	10.0566	71.7791	52
4976.4077	10/27/2014 2:03:33 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	13.1143	33K44	On	15.2700	13.7441	13.7879	72.8674	51
4964.9575	10/27/2014 2:11:08 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.7876	33K44	On	15.4600	8.2482	8.2930	77.8472	51

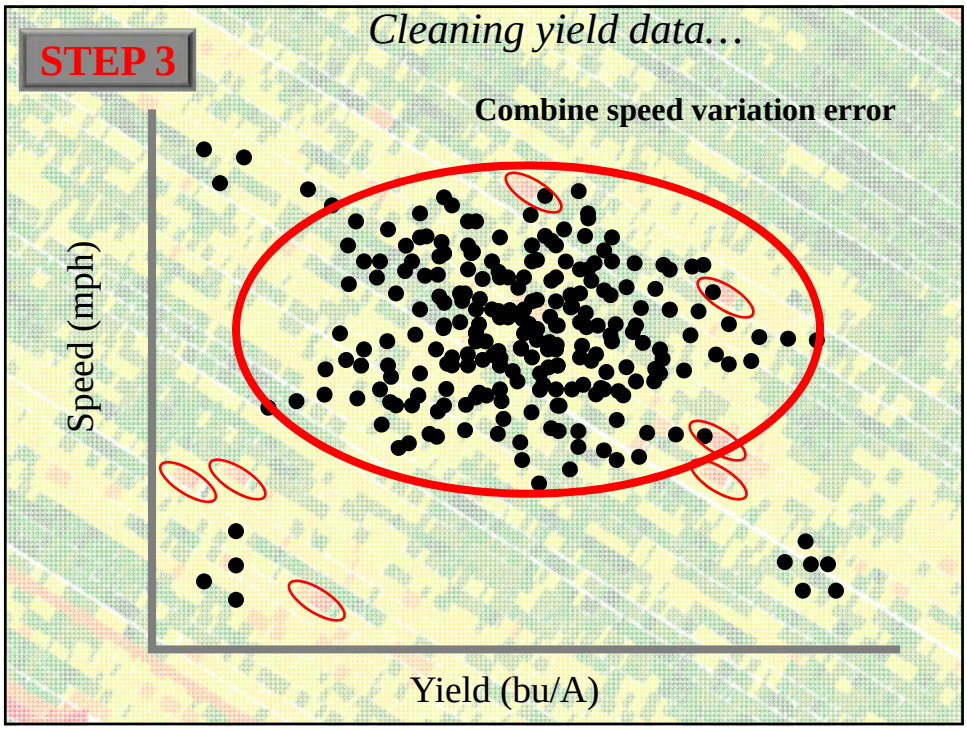


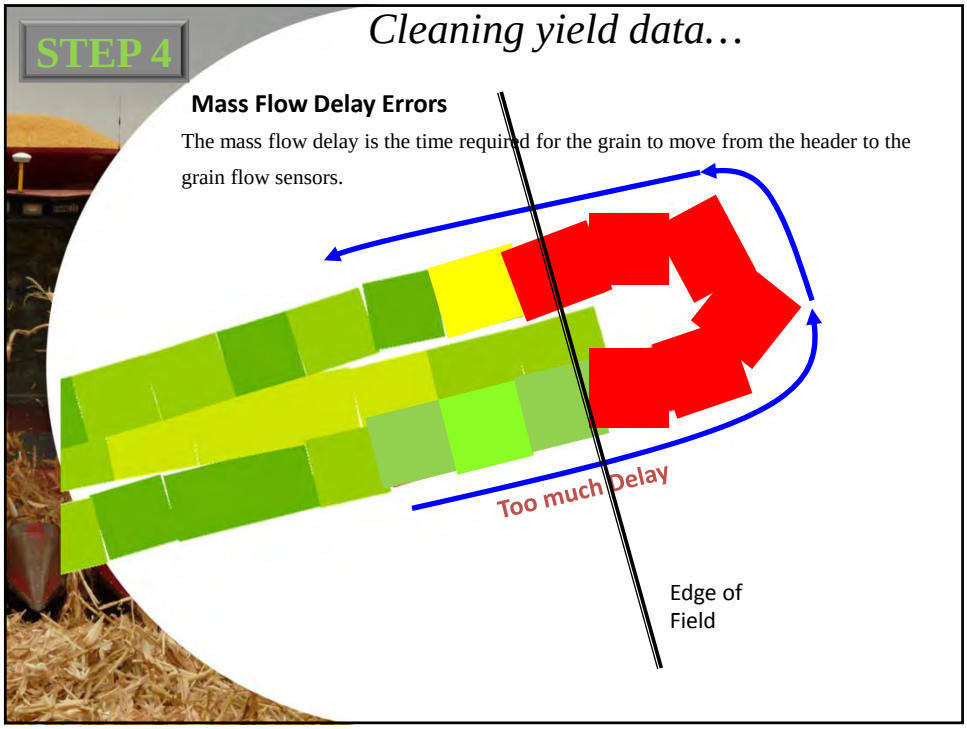
Elevatio	Time	Fix	Width	DelStatus	Relative	AirTempe	WindSpee	SoilTemp	WindDire	SkyCondi	SoilMois	FuelRate	Product0	Record01	HarvestM	YieldMas	YieldWet	DryYield	Loa
4968.9930	10/27/2014 2:06:12 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.8762	33K44	On	15.7500	12.9362	13.0514	3129.0389	51
4968.9667	10/27/2014 2:06:13 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.6819	33K44	On	15.7500	12.5647	12.6766	2226.5974	51
4968.9995	10/27/2014 2:06:14 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.0743	33K44	On	15.7500	11.9310	12.0372	2103.4717	51
4969.0717	10/27/2014 2:06:11 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.4139	33K44	On	15.7500	15.1214	15.2560	295.7761	51
4965.2987	10/27/2014 2:00:17 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.9081	33K44	On	15.0900	16.5612	16.5788	290.3996	51
4965.0527	10/27/2014 2:11:43 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.7837	33K44	On	14.9900	17.0858	17.0858	264.4017	51
4967.7200	10/27/2014 2:07:47 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.3214	33K44	On	15.8700	15.3393	15.4979	261.2457	51
4968.3696	10/27/2014 2:06:41 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	9.3253	33K44	On	15.4300	16.4657	16.5494	258.1751	51
4968.5238	10/27/2014 2:06:37 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.5195	33K44	On	15.4300	19.8165	19.9173	253.6774	51
4964.9313	10/27/2014 2:11:42 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.5592	33K44	On	14.9900	15.3662	15.3662	250.8908	51
4967.7102	10/27/2014 2:07:46 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.5647	33K44	On	15.8700	14.8074	14.9606	245.1437	51
4968.9700	10/27/2014 2:06:18 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.8987	33K44	On	15.7500	12.3025	12.4120	244.6757	51
4968.9142	10/27/2014 2:06:22 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.0308	33K44	On	15.7500	12.8707	12.9852	239.8781	51
4964.9608	10/27/2014 2:11:41 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.9477	33K44	On	14.9900	13.3159	13.3159	236.9992	51
4968.9503	10/27/2014 2:06:16 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.9384	33K44	On	15.7500	10.8821	10.9790	236.2434	51
4967.8972	10/27/2014 2:07:38 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.2251	33K44	On	15.8700	11.2332	11.3494	235.2494	51
4967.8053	10/27/2014 2:07:44 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.8233	33K44	On	15.4500	13.7326	13.8057	233.8810	51
4967.9398	10/27/2014 2:07:34 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.7270	33K44	On	15.6600	10.9375	11.0231	233.1756	51
4967.6741	10/27/2014 2:07:48 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.0402	33K44	On	15.8700	14.4486	14.5980	232.7034	51
4968.9930	10/27/2014 2:06:15 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.0705	33K44	On	15.7500	9.8770	9.9649	231.3692	51
4968.4418	10/27/2014 2:06:36 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.2025	33K44	On	15.4300	17.4036	17.4921	230.2476	51
4965.5448	10/27/2014 2:00:22 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.5328	33K44	On	15.0900	16.0327	16.0497	230.0838	51
4968.9011	10/27/2014 2:06:21 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.1893	33K44	On	15.7500	11.5377	11.6404	229.4649	51
4968.7436	10/27/2014 2:06:27 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.3346	33K44	On	15.6300	15.1210	15.2339	228.0432	51
4969.9346	10/27/2014 2:13:34 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	13.4464	33K44	On	15.6500	31.2631	31.5041	227.9263	51
4967.7430	10/27/2014 2:07:45 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	6.4458	33K44	On	15.8700	14.1148	14.2608	227.3274	51
4966.8801	10/27/2014 2:10:19 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	10.0385	33K44	On	15.1600	25.1954	25.2429	226.9565	51
4968.8913	10/27/2014 2:06:20 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	8.3875	33K44	On	15.7500	11.4066	11.5081	226.8574	51
4967.7987	10/27/2014 2:07:43 PM	3D Dif	20.00	FALSE	0.0000	0.0000	0.0000	0.0000	Unknown	Unknown	Ideal	7.2383	33K44	On	15.4500	13.4866	13.5584	226.4396	51

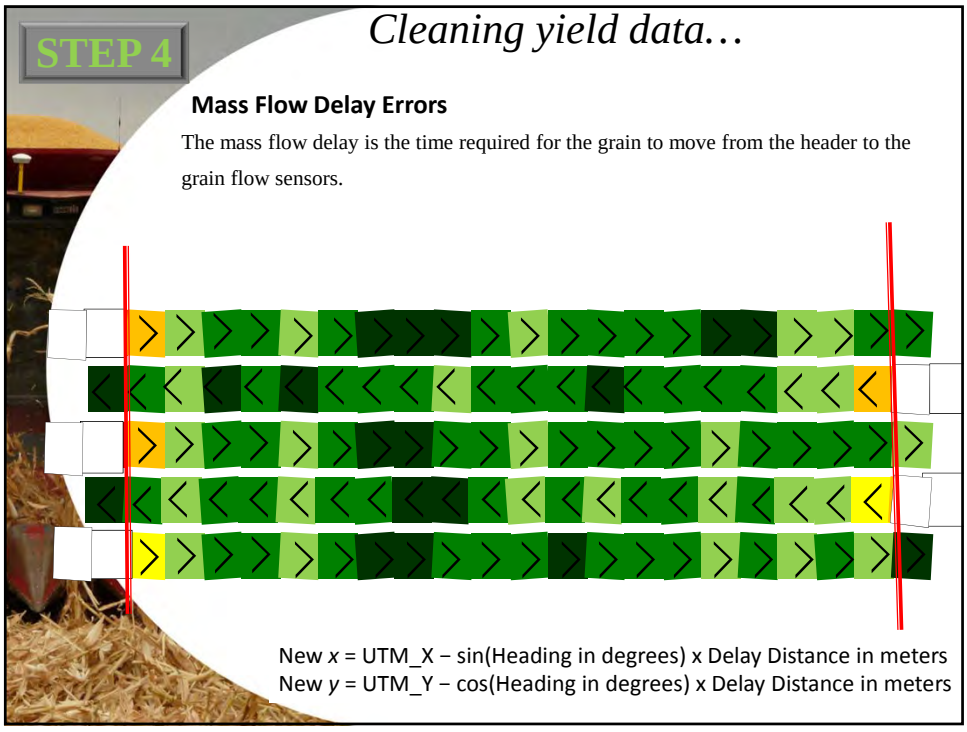

STEP 3
Cleaning yield data…
Combine speed variation error
GUINNESS WORLD RECORDS


STEP 3
Cleaning yield data…
Combine speed variation error
For cleaning, remove speed that is + or – 25% of the median
Speed (mph): 4.6 4.7 4.9 5.5 5.0 3.6
Yield (bu/A): 170 170 165 112 168 284
Area harvested in 1 second

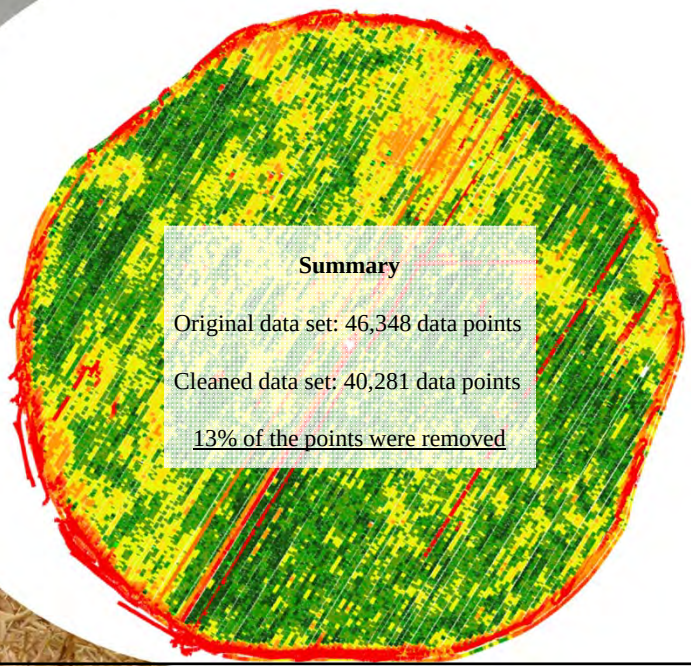

STEP 3
Cleaning yield data…
Combine speed variation error
For cleaning, remove speed that is + or – 25% of the median


STEP 3
Cleaning yield data…
Combine speed variation error
Speed (mph)
Yield (bu/A)


STEP 4
Cleaning yield data…
Mass Flow Delay Errors
The mass flow delay is the time required for the grain to move from the header to the grain flow sensors.
Too much Delay
Edge of Field


STEP 4
Cleaning yield data…
Mass Flow Delay Errors
The mass flow delay is the time required for the grain to move from the header to the grain flow sensors.
New x = UTM_X – sin(Heading in degrees) x Delay Distance in meters
New y = UTM_Y – cos(Heading in degrees) x Delay Distance in meters

Result of the Cleaning Process



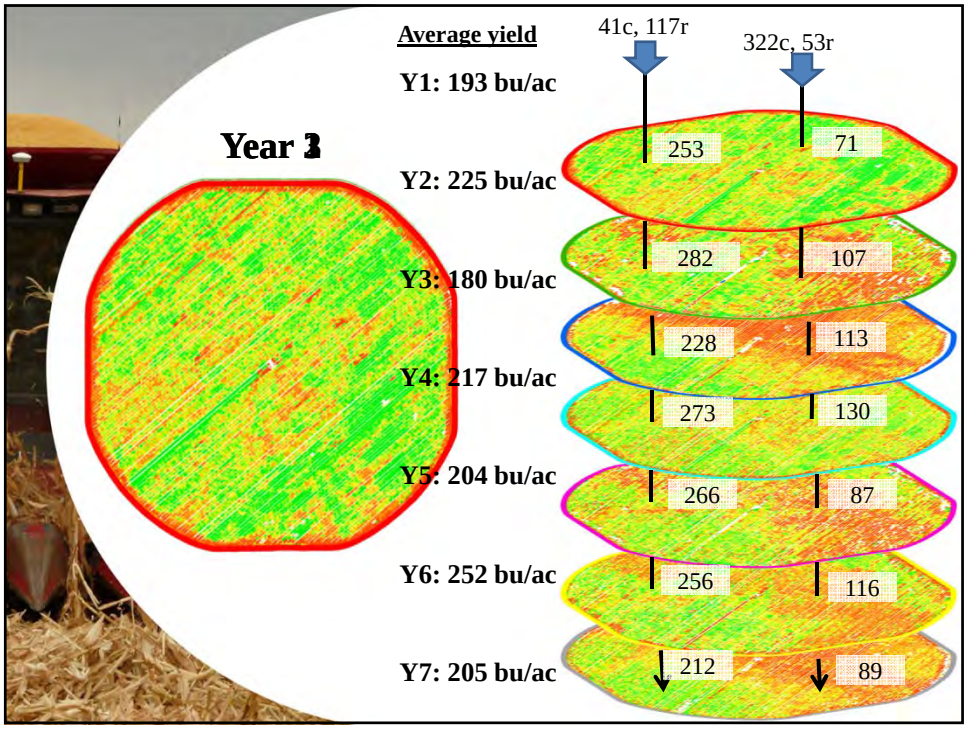
Summary

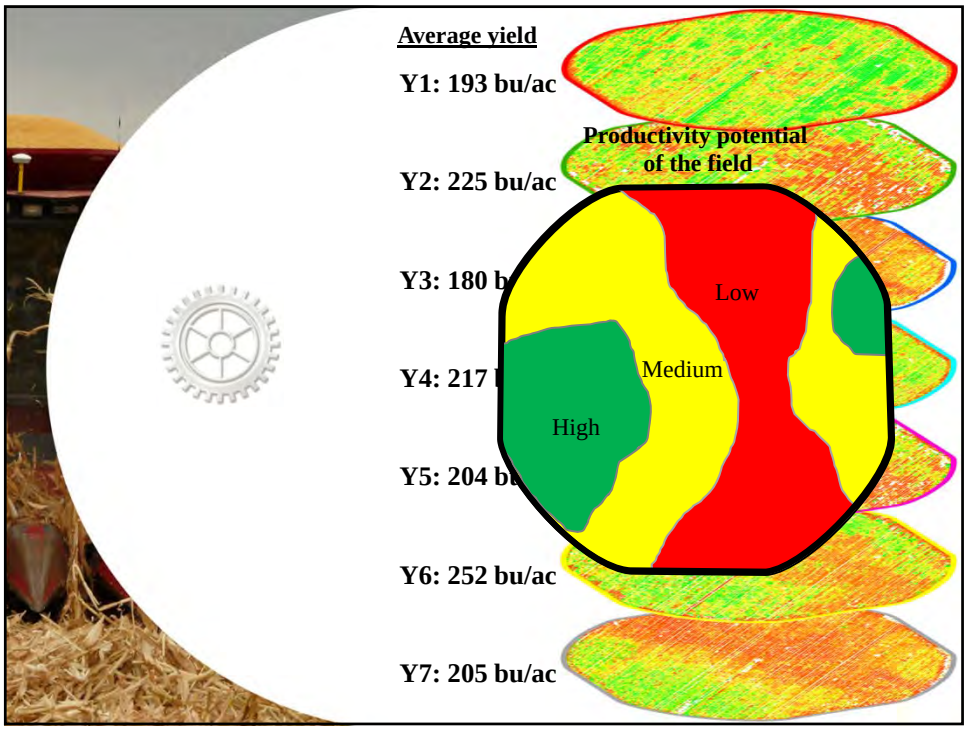
Original data set: 46,348 data points

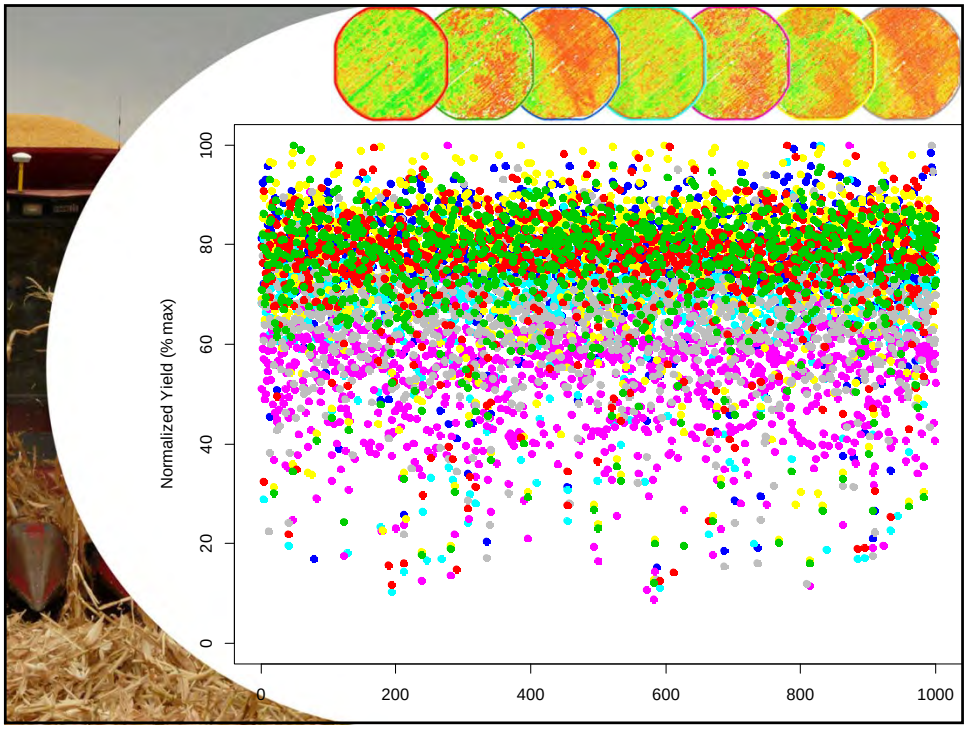
Cleaned data set: 40,281 data points

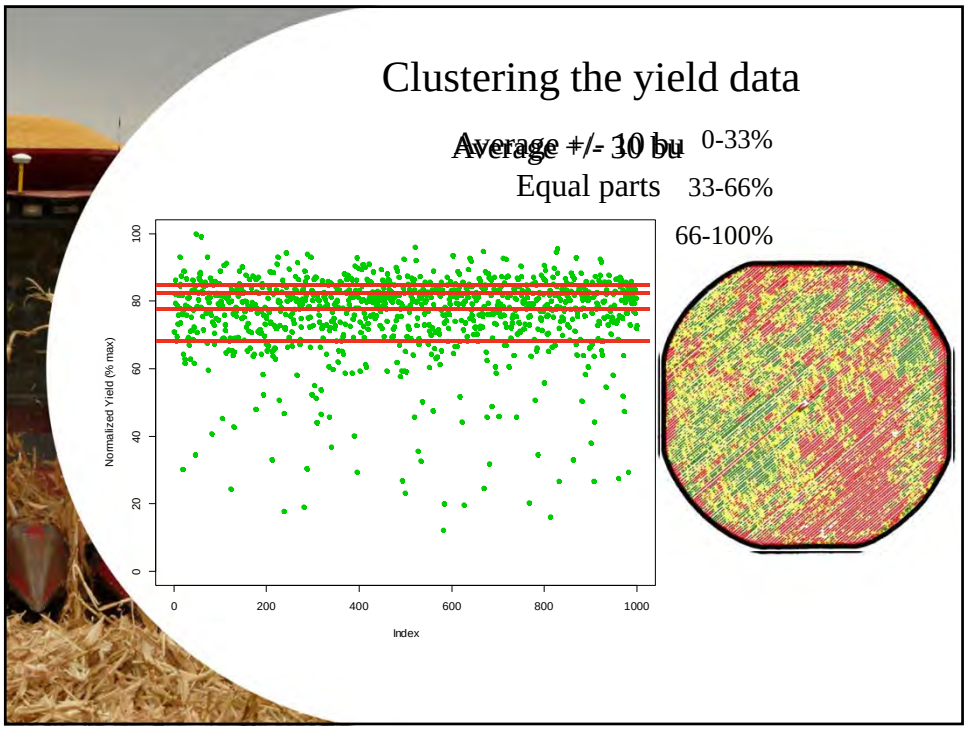
13% of the points were removed

Making Sense of Yield Data

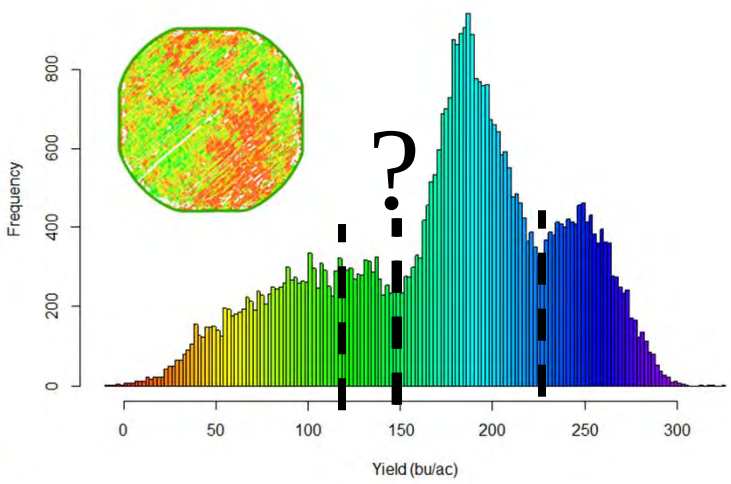

Average yield
Y1: 193 bu/ac
Y2: 225 bu/ac
Y3: 180 bu/ac
Y4: 217 bu/ac
Y5: 204 bu/ac
Y6: 252 bu/ac
Y7: 205 bu/ac
Year 3
41c, 117r
322c, 53r
253
71
282
107
228
113
273
130
266
87
256
116
212
89


Average yield
Y1: 193 bu/ac
Y2: 225 bu/ac
Y3: 180 b
Y4: 217
Y5: 204 b
Y6: 252 bu/ac
Y7: 205 bu/ac
Productivity potential of the field
Low
Medium
High


Normalized Yield (% max)
0
20
40
60
80
100
0
200
400
600
800
1000


Clustering the yield data
Average +/- 10 bu
Average +/- 30 bu
0-33%
Equal parts
33-66%
66-100%
Normalized Yield (% max)
0
20
40
60
80
100
0
200
400
600
800
1000
Index

Number of zones based on dataset



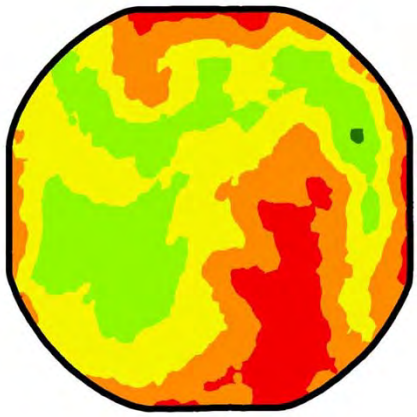
Generating zones

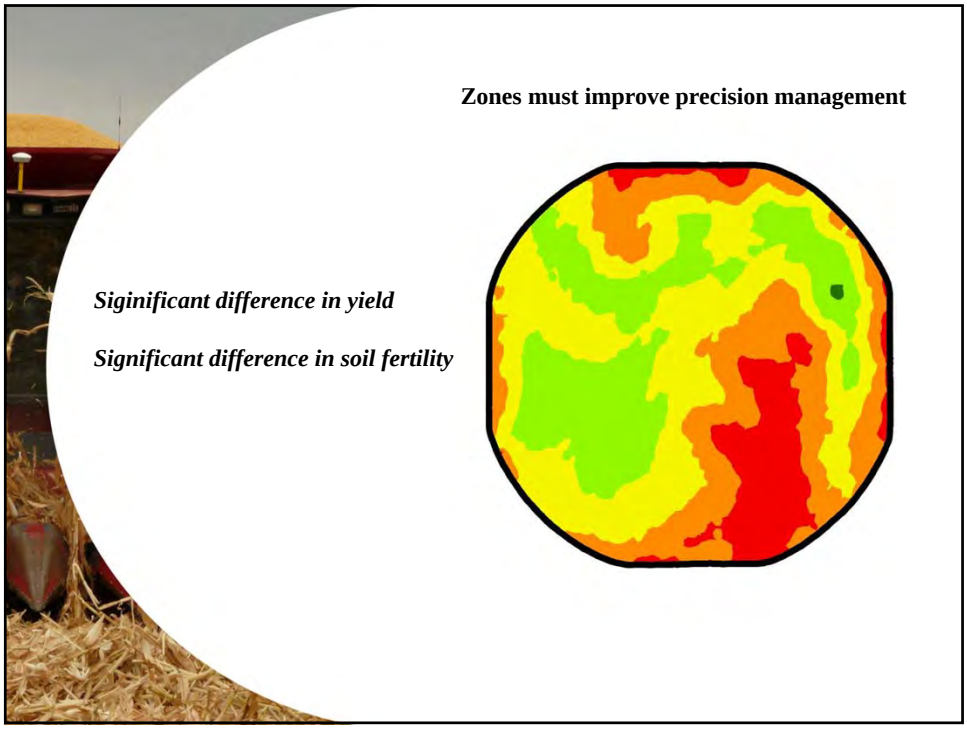
Optimal number of zones varies

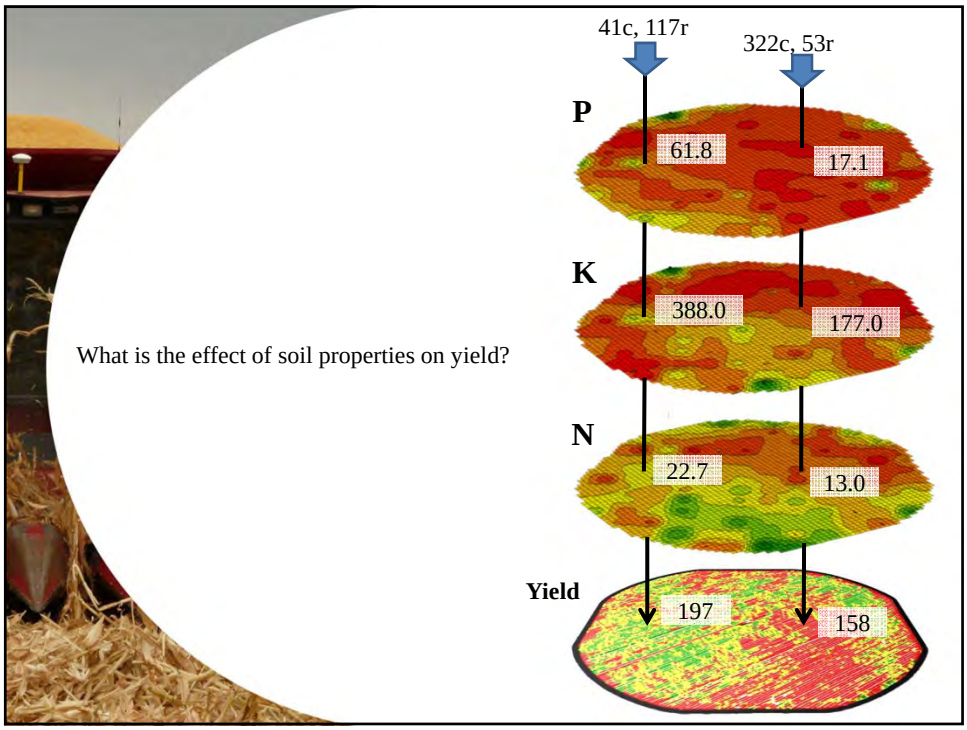
Black box generates zones

Are all zones significant?

4 zones




Zones must improve precision management
Siginificant difference in yield
Significant difference in soil fertility


What is the effect of soil properties on yield?
41c, 117r
322c, 53r
P
61.8
17.1
K
388.0
177.0
N
22.7
13.0
Yield
197
158

Thank you

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