

Yield Mapping and Use of Yield Map Data

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Crop raw yield monitor data.

Yield maps...may be predictive of yield potential and soil nutrient variability for future crop management decisions

Grain combine and harvester yield monitors have grown in popularity. New grain combines are marketed with GPS-linked yield monitors as standard equipment. More than 70 percent of U.S. farmers have GPS-linked yield monitors on their harvest equipment, and another 18 percent have yield monitors without GPS-linked harvesters.

Yield Monitors

Each brand of yield monitor comes with its own company support system for installation, operation and calibration. When purchasing a used harvester, establishing a personal connection with the support entity for its yield monitor will be important for its future operation and service.

The data generated with a yield monitor is only as good as the correct installation, calibration and maintenance of the unit and its components. Following the manufacturer's advice on daily service and seasonal calibration will be important for best data collection.

Yield Monitor Data Analysis

Even though yield monitor manufacturers normally sell computer software to help analyze yield data, growers may want to conduct their own analyses using commonly available data management software and geographic information system (GIS) software programs. Being able to export your data into useful files is important in analyzing yield data in data management software.

Choose a yield monitor capable of exporting data in .txt (text) format because this format is compatible with most database spreadsheets and GIS software programs.

A number of yield monitor data errors are associated with normal yield data collection. Here are some examples:

- The yield monitor may not shut off at the field end and will register "0" data until harvestable crop again moves into the combine.

Tips on correct installation and operation of yield monitors can be obtained from the manufacturer's recommendations and these suggested publications and websites:

- "Elements of Precision Agriculture: Basics of Yield Monitor Installation and Operation" by Shearer et al., Publication PA-, University of Kentucky. www2.ca.uky.edu/agcomm/pubs/pa/pa1/pa1.pdf
- "Precision Farming Tools: Yield Monitor" by Grisso et al., Publication 442-502, Virginia Cooperative Extension. <https://pubs.ext.vt.edu/442/442-502/442-502.html>
- "Yield Monitor Pocket Guide," DuPont Pioneer www.pioneer.com/home/site/us/agronomy/yield-monitor-pocket-guide/
- "Precision Agriculture: Best Management Practices for Collecting Accurate Yield Data and Avoiding Errors During Harvest" by Luck et al., Publication EC2004, University of Nebraska-Lincoln Extension. <http://extensionpublications.unl.edu/assets/pdf/ec2004.pdf>

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North Dakota State University
Fargo, North Dakota

Revised May 2018

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- The combine grain-flow system may plug temporarily, especially if the crop has lodged or weeds interfere with continuous grain flow.
- A lag can occur between the time the crop is cut and the time its yield is measured in the grain flow.

These anomalies must be deleted from the dataset if you want to construct meaningful maps that represent the true spatial yield values in the field. In some fields, a 0 yield is not possible, and the farmer would know this if grain was within all the borders of the field.

However, in some years, high rainfall might result in 0 yield in depressions, and noting that to the yield monitor cleaner will be important. Also, high soil salt areas that have 0 areas are very common in North Dakota. Being able to map real 0 yield is important, but remember to delete those data that are errors.

High yields also should be deleted. In a wheat harvest, for example, yield in a field averaging 80 bushels per acre might achieve 150 bushels per acre in a particularly perfect area of the field, but a yield of 250 bushels per acre is not real and should be deleted. Choosing a limit for allowable high yield is as important for realistic field mapping as deletion of false 0 yield.

If a farmer only has to clean a few fields, using a spreadsheet such as Microsoft Excel is possible. Sort yields from low to high, and choose a low yield that is appropriate for the field and a high yield that is reasonably attainable, then delete all data outside of those high and low parameters.

However, many growers have a large number of fields and have little time for laborious data analysis. Some precision ag providers can clean the data for you, or you might want to use more automatic yield data clears such as a software package available free of charge from the U.S. Department of Agriculture-Agricultural Research Service. It can be downloaded from www.ars.usda.gov/research/software/download/?softwareid=370 (Suddoth, 2007).

Yield Monitor Mapping

Because small spatial errors occur among yield measurements, yield monitor data usually are displayed as maps in larger zones of varying yield ranges, rather than displaying thousands of different colored points each representing single measurements. A zone-classified yield map is especially useful to farmers because it shows that yields vary throughout the field, such as where yields are high, low and in between, without the clutter of individual dots that vary widely in value.

For visual display, choose yield increments that make sense. For example, in a corn field that averages 200 bushels per acre, displaying ranges of 20 bushels per acre is probably appropriate. A display with ranges of 10 bushels per acre would produce a very “busy” map that would make interpretation difficult.

In contrast, a spring wheat field that averaged 40 bushels per acre probably would benefit from yield ranges of 10 bushels per acre. The meaningful range for a field depends most often on the scale of yields for the field.

Use of Yield Monitor Data and Yield Maps

Yield monitor maps can be a powerful tool to explain to family and other landowners about the need for tile and explain the yield drag in salty areas of the field and the need to management these areas differently. Yield maps also are a valuable archive of field performance and the changes that management might have had on the fields.

The archived maps can be shared with bankers to help secure loans and with future renters or land purchasers. The maps can be passed down to the next generation so that the things farmers learn about their fields will not be lost to heirs.

Yield maps also are useful in product testing or any on-farm research the farmer decides is worthwhile. When strips of treatments are applied across a field, the stream of yield data from the strips can be analyzed statistically. Yield data from multiple years' results in a good tool on which to base nutrient management zones for soil sampling and variable-rate nutrient application.

One year sometimes can result in the “perfect” map, but a much stronger, reliable tool is the multiyear yield map. A multiyear yield map may be constructed from a single crop such as corn planted each year, or a full crop rotation with two, three or more crops in series.

In a continuous crop choice, some data modification is required. One year a corn crop might average 150 bushels per acre, in the next 200 bushels per acre and the next 120 bushels per acre. If you used actual bushels to construct the multiyear map, the year with the highest yield would weight the map, and the patterns of high and low yield mostly would reflect that year.

In a multicrop sequence, the yield scale also will show a difference. High yield in wheat might be 100 bushels per acre, soybeans 60 bushels per acre and corn 200 bushels per acre. If actual yields were summed, the corn year would most represent the map, with lesser weight to wheat, then the least input from soybean.

A method to consider each year equally is a process called “normalization.” The yield data for the field is

20	30	25	22	23	25	28	29	30	31	32	29	28	30	40	44	45	48	47	35	30	28	26	25
25	28	23	20	24	26	30	32	33	35	40	36	29	35	38	46	47	50	52	53	43	35	28	28
28	28	26	25	28	30	34	35	38	40	40	42	38	38	36	40	45	48	53	45	43	38	38	36
30	30	32	34	35	38	37	40	40	43	45	46	44	45	46	48	46	45	48	49	49	45	46	
32	32	33	35	35	36	38	40	42	42	44	46	44	44	38	37	40	42	41	45	47	50	48	47
34	34	35	36	36	35	35	33	40	32	38	35	36	40	42	43	44	45	46	38	37	40	41	42
38	38	39	39	40	38	42	45	56	50	52	53	48	35	37	38	40	42	44	46	37	38	39	40
36	38	40	42	44	45	48	50	52	46	38	36	35	43	44	46	48	50	52	53	54	52	48	48
35	35	36	38	39	42	44	44	46	42	40	38	37	36	38	39	40	42	44	46	48	48	52	48
34	34	36	38	40	42	43	41	44	38	36	38	39	39	39	41	42	41	43	44	45	44	43	

An example of raw yield monitor data from a field of spring wheat in bu/acre.

20	30	25	22	23	25	28	29	30	31	32	29	28	30	40	44	45	48	47	35	30	28	26	25
25	28	23	20	24	26	30	32	33	35	40	36	29	35	38	46	47	50	52	53	43	35	28	28
28	28	26	25	28	30	34	35	38	40	40	42	38	38	36	40	45	48	53	45	43	38	38	36
30	30	32	34	35	38	37	40	40	43	45	46	44	45	46	48	46	45	48	49	49	45	46	
32	32	33	35	35	36	38	40	42	42	44	46	44	44	38	37	40	42	41	45	47	50	48	47
34	34	35	36	36	35	35	33	40	32	38	35	36	40	42	43	44	45	46	38	37	40	41	42
38	38	39	39	40	38	42	45	56	50	52	53	48	35	37	38	40	42	44	46	37	38	39	40
36	38	40	42	44	45	48	50	52	46	38	36	35	43	44	46	48	50	52	53	54	52	48	48
35	35	36	38	39	42	44	44	46	42	40	38	37	36	38	39	40	42	44	46	48	48	52	48
34	34	36	38	40	42	43	41	44	38	36	38	39	39	39	41	42	41	43	44	45	44	43	

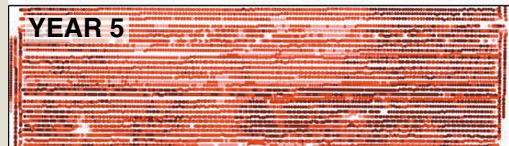
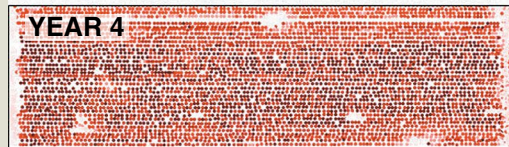
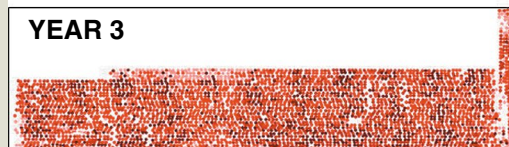
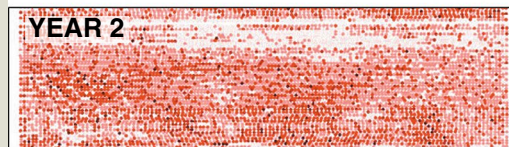
During the normalization process, a grid is superimposed over the data. The software recognizes the set boundaries for averaging the data inside each grid box.

24	29	33	36	47	30
29	34	41	42	47	43
34	36	40	41	43	44
39	44	48	41	47	45
36	42	40	38	42	47

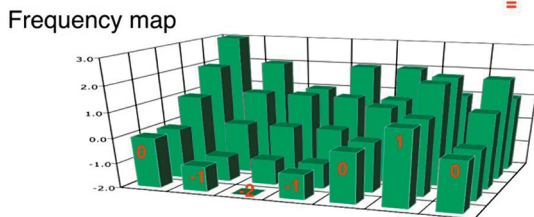
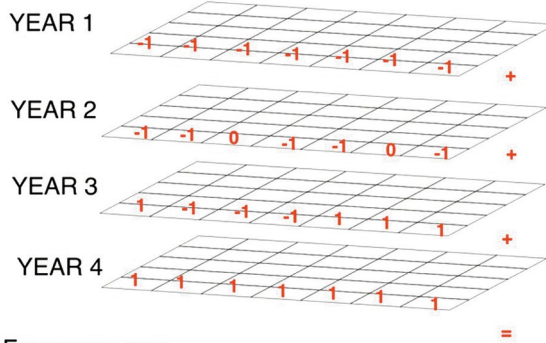
The data are averaged within each grid box independently of the other data.

-1	-1	-1	-1	+1	-1
-1	-1	+1	+1	+1	+1
-1	-1	+1	+1	+1	+1
0	+1	+1	+1	+1	+1
-1	+1	+1	-1	+1	+1

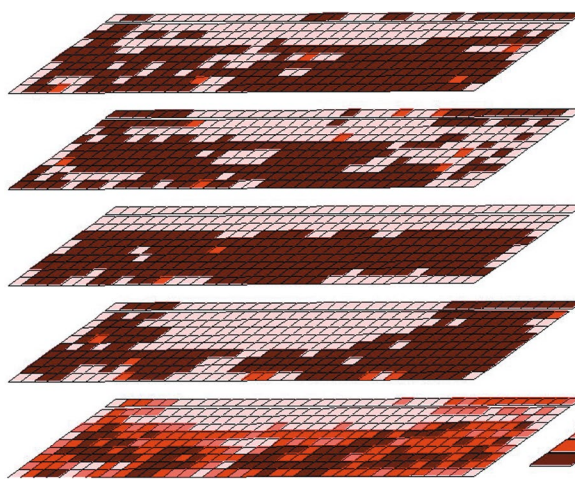
If the data average within the grid is higher than average, the grid is given a +1. If average, it is given a value of 0. If the average within the grid is lower than average, the grid is given a -1. Afterward, this data can be exported into a spreadsheet for summing multiple years of yield data that have been handled similarly. The resulting summation can be imported into mapping software to construct the yield frequency map.



A series of five years of crop raw yield monitor data of the same field. Missing data can be normalized by weighting yields by years of data so the large area of missing data in the third yield map is divided only by 4 instead of 5, or normalized by the summation multiplied by 1.25, to compare favorably with data from five years of maps instead of the four it has available.

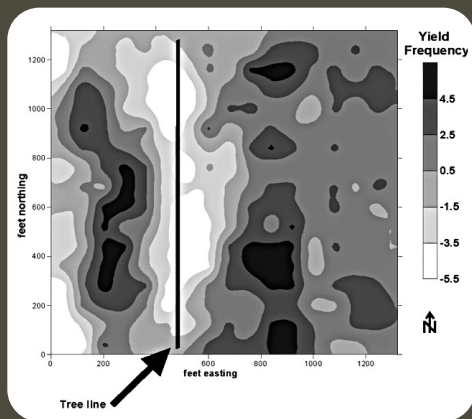


Each year's data are superimposed with the same grid. Yields are averaged within each grid. +1 is given to grids greater than average for the field, -1 for grids lower than the average and 0 for the rare grid that is within a half-bushel of average. These grids then are summed individually within a spreadsheet and remapped into the mapping software.

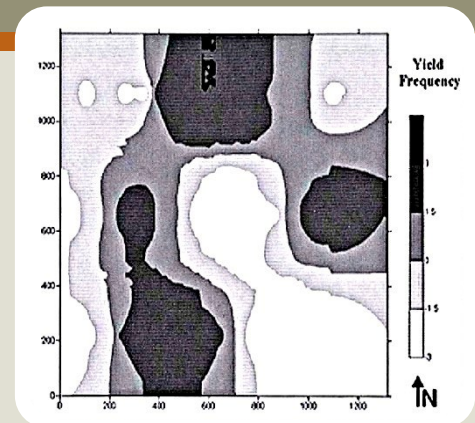


A visual depiction of the four years of individually normalized yields summed and mapped as a yield frequency map (bottom map).

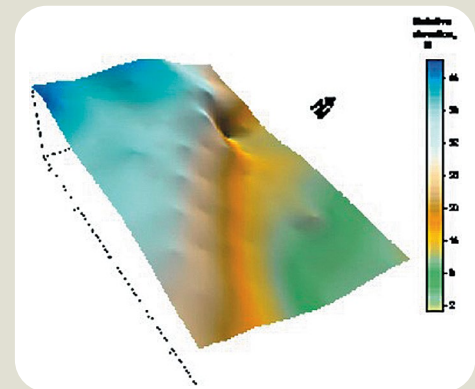




A yield frequency map depicting a corn and soybean rotation in Illinois in a five-year period (from Franzen, 2008). Each individual year did not show all of these patterns. Meaningful long-term trends in yield were revealed with accompanying relationships to soil phosphorus, potassium and pH (acidity or alkalinity) levels only following the combination of years.



Yield frequency map at Williston, N.D. (top), with lower yields on the ridge slope (southeast to northwest direction) and higher yield in the more level areas above and below the ridge slope (southwest and northeast) (elevation image on the bottom).



divided by the highest yield in the field, resulting in values between 0 and 1. If the high yield in wheat was 100 bushels per acre, all yield values in the field are divided by 100, resulting in values from 0 to 1. In corn with the high yield of 200, all yields in the field are divided by 200, resulting in values from 0 to 1, and so on for each year.

Another way to normalize yield data is to normalize at the end of the analysis and not at the beginning. Using the following figures as an example, first impose a grid on the yield data that makes sense. A field should have at least 40 grids imposed to make a meaningful map at the end of the exercise. For example, a user might choose to superimpose 40 1-acre grids over a square 40-acre field. A quarter-section might have 80 2-acre grids. A 20-acre field might have 1/2-acre grids.

To create the grids and the average yield within a grid, use a software program such as Surfer (Golden Software Co., Golden, Colo.) or ArcGIS (ESRI GIS Software Co., Redlands, Calif.) that can import spatial data and then convert them to estimated values based on a user-specified grid size. This estimation feature usually is used in grid soil sampling to take less dense spatial values (perhaps 16 in a 40-acre field) and estimate the values in between sample locations.

However, it also is useful in taking very dense data, such as thousands of yield measurements, and generating grids as described previously. After generating the grids and yield averages, the data can be saved in a text (.txt) file and exported into a spreadsheet file.

Within the spreadsheet, the grid is given a +1, -1 or 0 value, depending on whether the average of the grid is greater than the field average, less the field average or within 1/2 bushel per acre of the field average. Giving the +1, -1 or 0 value is a normalization procedure. The normalized grids can be exported into a spreadsheet and summed by grid for each year of data that is treated in the exact same manner. In this way, two, three or more years

can be combined to produce a more meaningful multiyear yield map.

The multiyear yield map has been used as a zone layer for revealing residual soil nitrate, phosphate, potassium soil pH, and other crop nutrients and soil factors. The multiyear yield map also is useful in revealing areas requiring special management, such as a change in nitrogen application timing or a change in drainage. It can reveal yield drag due to salinity, sodicity and differences in soils within the field.

References

- Suddoth, 2007. Yield editor software. USDA-ARS. www.ars.usda.gov/services/software/download.htm?softwareid=20
- Franzen, 2008. Summary of forty years of grid sampling in two Illinois fields. NDSU Technical Report.

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