Precision Agriculture

Lesson 2 Educator's Guide

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Nebraska Precision Agriculture Curriculum

Contents

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Lesson 2: Precision Agriculture: What it can do.

Lesson Objectives

1. Learn about the differences and relationship between Hardware and Software
2. Lean about the different ways the Precsion Agriculture is used
3. Learn how Precision Agriculture is useful for different scales of operations and how it can be used to fit the needs of their operators
4. Lear what inputs can be controlled using Precision Agriculture.
5. Learn what maps are created using Precision Agriculture and how to interpret what the maps show

Vocabulary

NOTE: For the purpose of this lesson, definitions are geared toward Row crop farming even when animal and herd practices exist.

- Hardware – The mechanical equipment necessary for conducting an activity.
- Software – The programs used to direct the operation of hardware.
- Variable Rate – The management practice where the rate an input is applied is changed to match the needs of a specific area of a field.
- Scalability – The ability to adapt and apply a practice to different operations regardless of the size of the operation.
- Sensor Array – A piece of hardware that uses several different sensors to gather information about something from a single spot.

Types of Hardware

Any electronic technology system consists of Hardware and Software. Hardware is the mechanical equipment that is needed to conduct an activity within the system of which it is a part. Software is the computer program that controls what the hardware does, how fast it does it and how much pressure is applied while doing it. Because there are a number of different tasks that need to be done, there are many different pieces of hardware to accomplish those tasks.

Within Precision Agriculture, there are 3 main types of hardware: Sensors, Meters, and Monitors.

Sensors, as the name suggests, are hardware that “senses” something. They can use lasers, light emitters, thermometers (measures temperature), hygrometers (measures moisture), impact plates (measure how hard something hits the plate which indicates mass), scales (measures physical weight), and gauges. There are sensors that measure the amount of something in a tank, the presence or

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absence of something, the angle or slope of a hill the equipment is sitting on, the direction of travel, speed of travel. Location on a map, when a seed is planted, how close the seeds are, if a seed is missing, if more than one seed is planted, how much of something is being used, and many other characteristics of the environment.

An example of a sensor is the PrecisionPlanting SmartFirmer. The SmartFirmer is actually a Sensor Array. A sensor array appears to be a single sensor, but in fact measures many different characteristics about a single place at a single time. The SmartFirmer for instance can gather many points of information about the soil that a seed is being planted. These points of information include soil moisture, soil temperature, the quality of seed to soil contact, and the amount of organic matter in the soil.

PrecisionPlanting SmartFirmer

The SmartFirmer is an example of a very complex highly technical set or 'array' of sensors.

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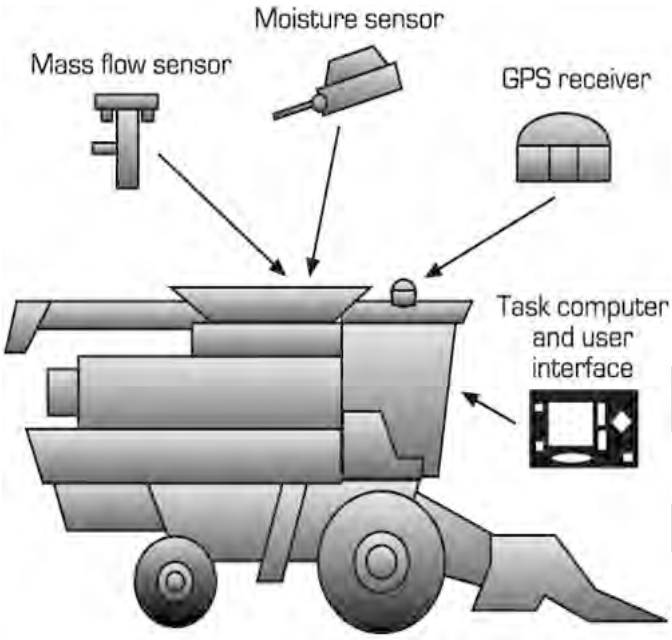
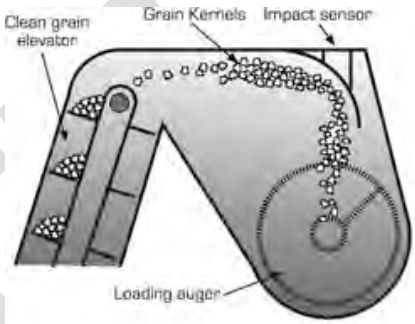
A more simple example of a sensor is the Mass Flow Sensor which measures the weight of grain being harvested and the Moisture Sensor which measures the amount of moisture in the grain on a combine.



The Mass Flow sensor is placed in the flow of clean grain on the combine and measures the force of the grain that that hits the impact sensor. The software built into the sensor converts the force of the grain hitting the sensor into weight.



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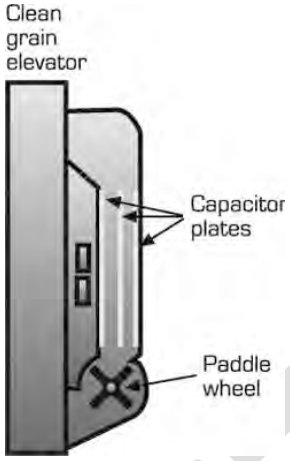
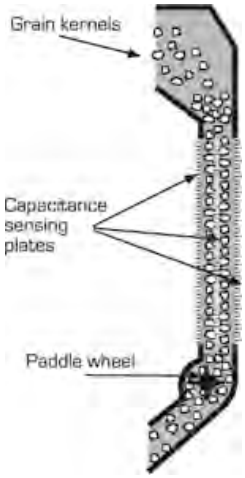
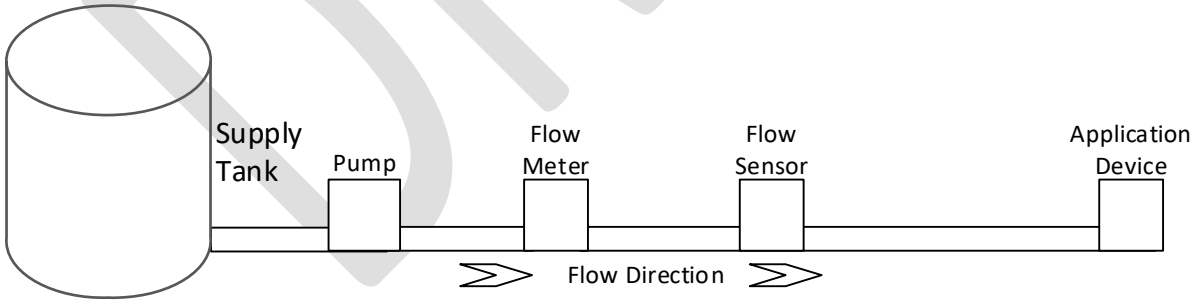
The Moisture Sensor is also place inside the flow of clean grain. As the grain passes along a set of capacitor plates, the amount of moisture within the grain is recorded. Software then takes the moisture and the grain weight along with the location gathered by the GPS receiver and puts them all together to calculate the yield and allows the creation of a yield map.





A meter controls the amount of something that is applied. This is an example of a meter is the flow meter produced by Raven Industries. Flow meters are valves that are electronically controlled. A flow meter works in conjunction with a flow sensor to control the amount of fluid that is allowed to flow through a delivery system whether it is a sprayer, injector, or transfer system.

Example of a simple delivery system.



This is an example of a simple fluid delivery system. Fluid is pulled from the tank and pushed through the system by a pump. A flow meter is located next to allow the designated amount of fluid to be released. A flow sensor checks the amount of fluid being supplied by the Flow Meter and sends a signal for the flow meter to adjust the flow to the correct amount. This ensures the application device is delivering the proper amount of fluid.

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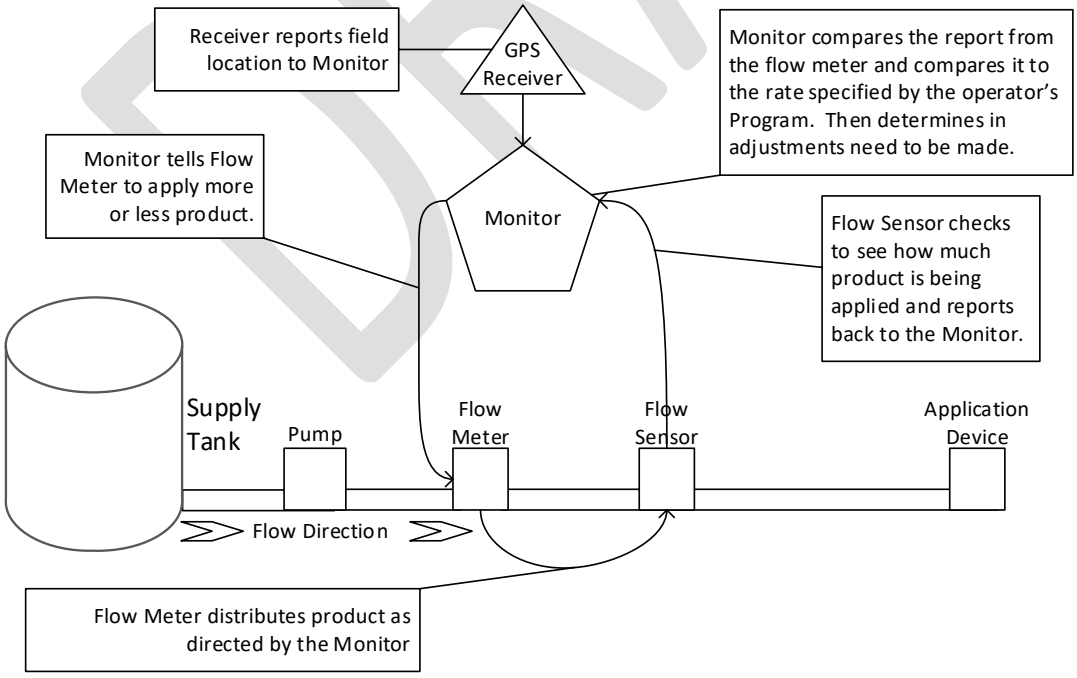
A monitor is a piece of hardware that contains the "brains" of the system. It takes the signals from the flow sensors and compares the rate to the desired rate for that part of the field based on a specific program written by the operator, and interprets if any adjustment is needed. When adjustments are needed, the monitor sends out a signal to the meter to correct its flow. This is an example of a monitor from AgLeader. The monitor on the left shows an example of someone doing some work in a field. The green shows the area that has been completed. The lines show where the tractor needs to go in order to complete that pass.

This is an example of a simple complete Precision Agriculture system. A full scale system will include many meters and sensors of differing types, controlling different products at the same time. The Monitor captures all the information supplied by the sensors so that it can be analyzed later for future planning and evaluation of management decisions.



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Assignment: Find 3 manufacturers of Precision Agriculture hardware.

Assignment: Two examples of how Precision Agriculture can be used were given in class (yield Monitors to record Yield and Moisture in a field, and Liquid delivery systems to control how much product is applied to specific locations on a field. Find 2 examples of how Precision Agriculture is used. Can be for grain or livestock production.

NOTE: wait will assignment on how Precision Agriculture can be used is completed prior to discussing scalability, types of maps, and inputs that can be controlled.

What can be controlled?

To this point, we have discussed controlling seeding rates, hybrid/variety placement, and fluid rates, but there is almost no end to the inputs that can be controlled and environment conditions that can be monitored. Here is a list of some of the inputs that can be controlled by Precision Agriculture management practices:

- Seed Hybrid/Variety – Can change as the planter moves across the field.
- Seed Spacing (seeding rate)
- Seed Depth
- Irrigation
    1. When it's time to water
    2. How much is applied
    3. Can be varied as the pivot moves across the field
- Fertilizer
    1. Initial fertilizer application – can be varied according to prescribed program
    2. Starter fertilizer rate at the time of planting – can be varied according to prescribed program and applied right at the root zone.
    3. Subsequent fertilizer applications – can be varied according to prescribed program
    4. Granular fertilizer for pastures – can be varied according to prescribed program
- Herbicides
    1. Rate can be varied based on weed pressure
    2. Weed types can be identified by sensors and the right herbicide can be applied to the area it is growing
    3. Can be shut off on areas that is unlawful to apply herbicides like in water ways and setbacks.
- Fungicides

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In addition to what can be controlled, there is a huge list of environmental factors that can be monitored such as:

- Plant health
- Soil moisture at different levels without having to visit each field
- Soil temperature
- Soil PH
- Organic matter
- Yield
- In Animals
    1. Location
    2. Maximizing milking
    3. Last time an animal drank
    4. Last time an animal ate
    5. Body temperature
    6. Heart rate
    7. (think FitBit for livestock)
    8. Can even act as an invisible fense for cattle grazing management

From Iowa Farmer Today: Scientists found that use of thermal images showed promise in determining heat tolerance for pigs

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From http://www.precisionag.com/systems-management/using-iot-to-increase-efficiency-productivity-for-livestock/ :

Scalability of Precision Agriculture

There are a few myths about Precision Agriculture among operators. One is that I have to be a big farmer to use Precision Agriculture. This is false. Precision Agriculture can be used regardless of the operation size. For instance, the components for a 4-row planter or a 48-row planter are the same, you just need fewer of them for the 4-row planter. All the benefits can be realized on the 4-row planter as on the 24-row planter. Consistent, correct seed placement along with varied rates to match what the soil can best handle, changing the seed hybrid or variety to the one best suited for the soil, to ensure the seed is planted at an adequate depth with the best seed to soil contact and with the correct amount of starter fertilizer applied. In fact, according to a study done by Ken Ferrie, Farm Journal Field Agronomist, as presented at the 2017 Farm Journal AGTech Expo, operations of fewer than 500 acres had a shorter ROI for Variable Rate Fertility than operations of over 500 acres. Quite often with ROIs of less than 1 year.

Another myth is that an operator has to implement an entire Precision Agriculture package across they operation in order to see a benefit. While the more areas an operator can apply Precision Agriculture to the operation, the greater the impact and the better informed decision making, an operation can benefit with a single area of implantation. Take into account the 2.6 bushels of yield, per percent of Singulation, per acre recovery by having exactly 1 seed planted at the exact spot and at the right depth. It is not uncommon to have a 5% skip or double planting scenario which will account for a 13 bushel per acre loss in yield. At $3.50 per bushel, that equates to over $45 per acre in income per acre. At 500 acres, that is $22,500 per year just looking at a single aspect of planting with Precision Agriculture. Other aspects of Precision Agriculture planting that will increase that number even more is the ability to specify which hybrid you want planted where and at what population which will increase the per acre profitability even more.

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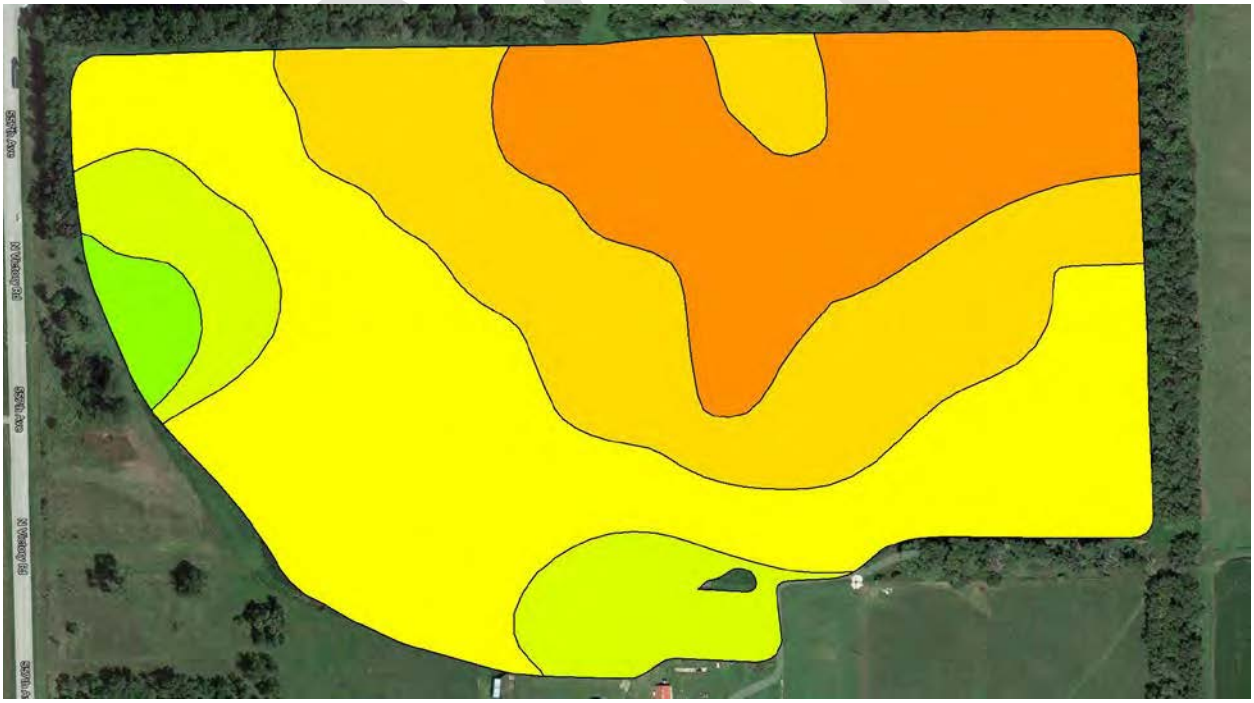
Another myth is that an operator has to buy all new equipment in order to implement Precision Agriculture costing additional tens if not hundreds of thousands of dollars. The truth is almost any age equipment can be equipped with Precision Agriculture technology. You just have to find the vender to do it. Three of the best known venders who equip older equipment with Precision Agriculture technology are PrecisionPlanting, AgLeader, and Raven Industries. By being able to retrofit current equipment, the entry cost of Precision Agriculture can be surprisingly low and pay big dividends.

Types of Precision Agriculture Maps

Because we are able to gather different pieces of information about small areas of each field and track where that piece of information was gathered, we are able to produce visual images of that data in the form of field maps. Each king of map displays a different kind of data. The following are some examples of the kinds of maps that can be generated:

Organic Matter Map



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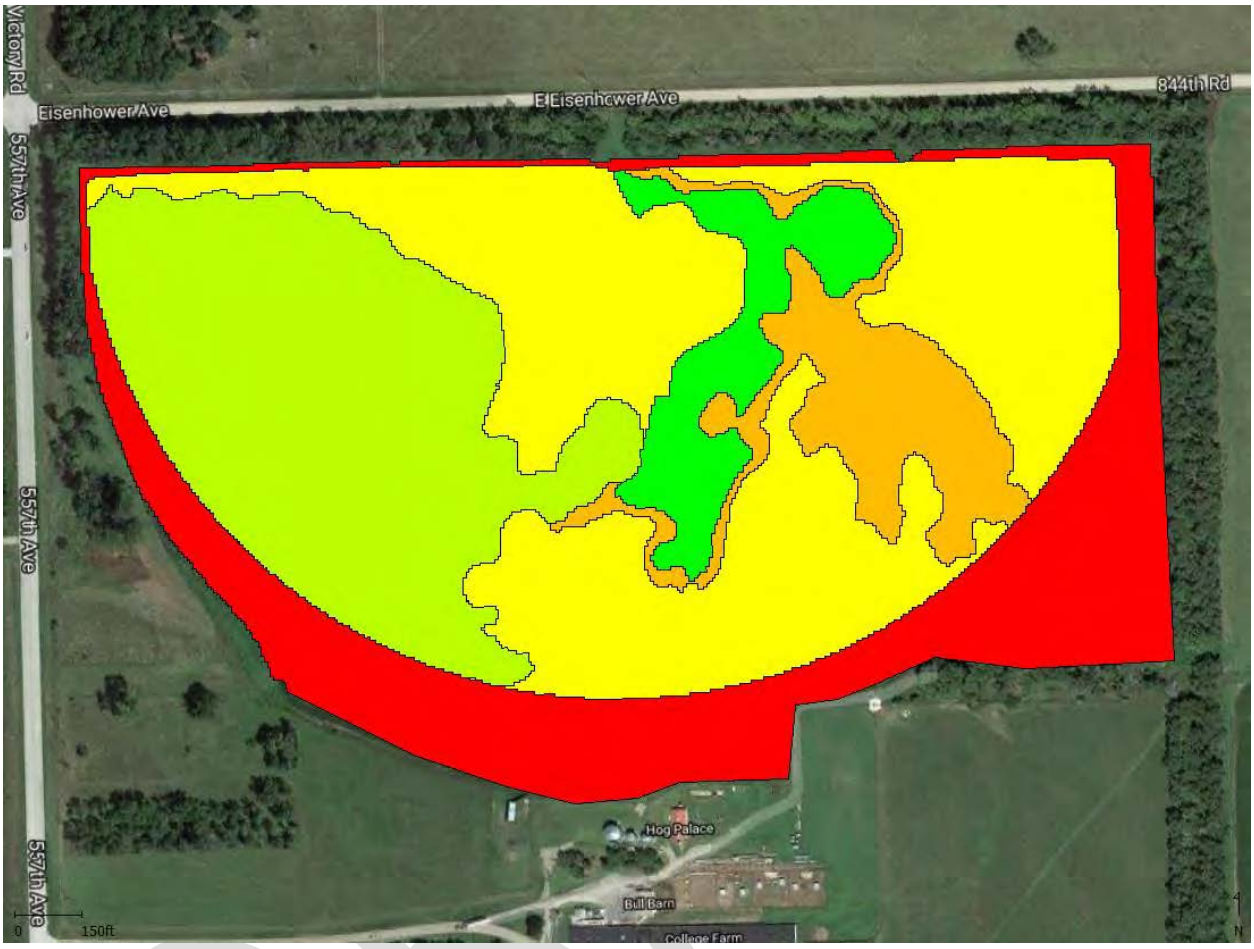
Fertilizer Application Map



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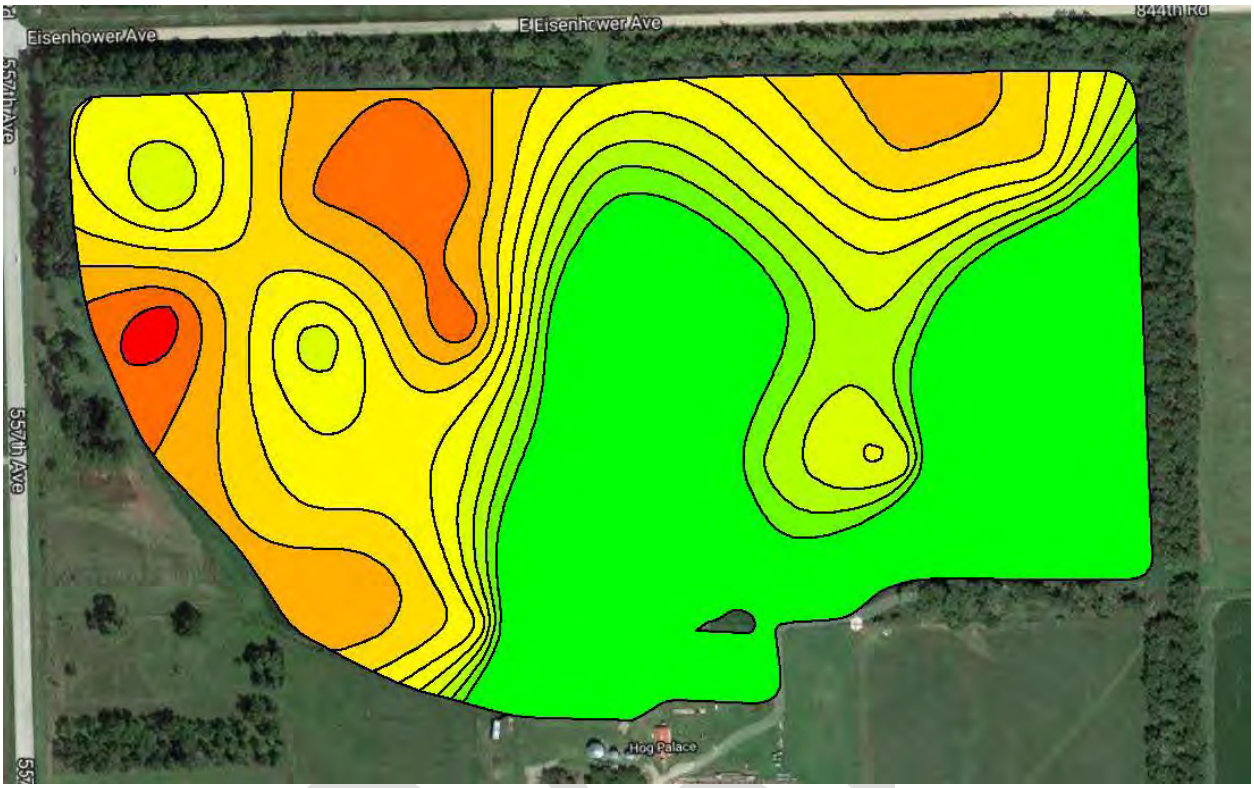
Soil Phosphorus Map



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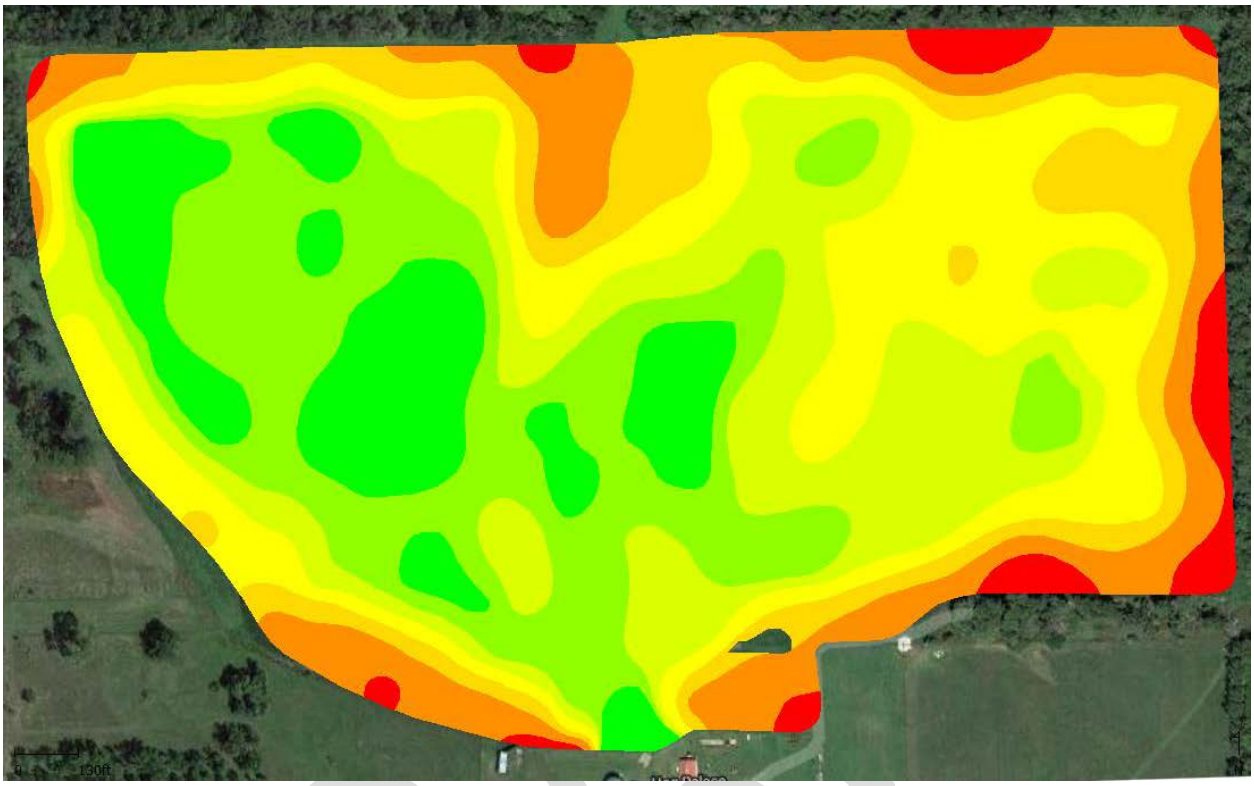
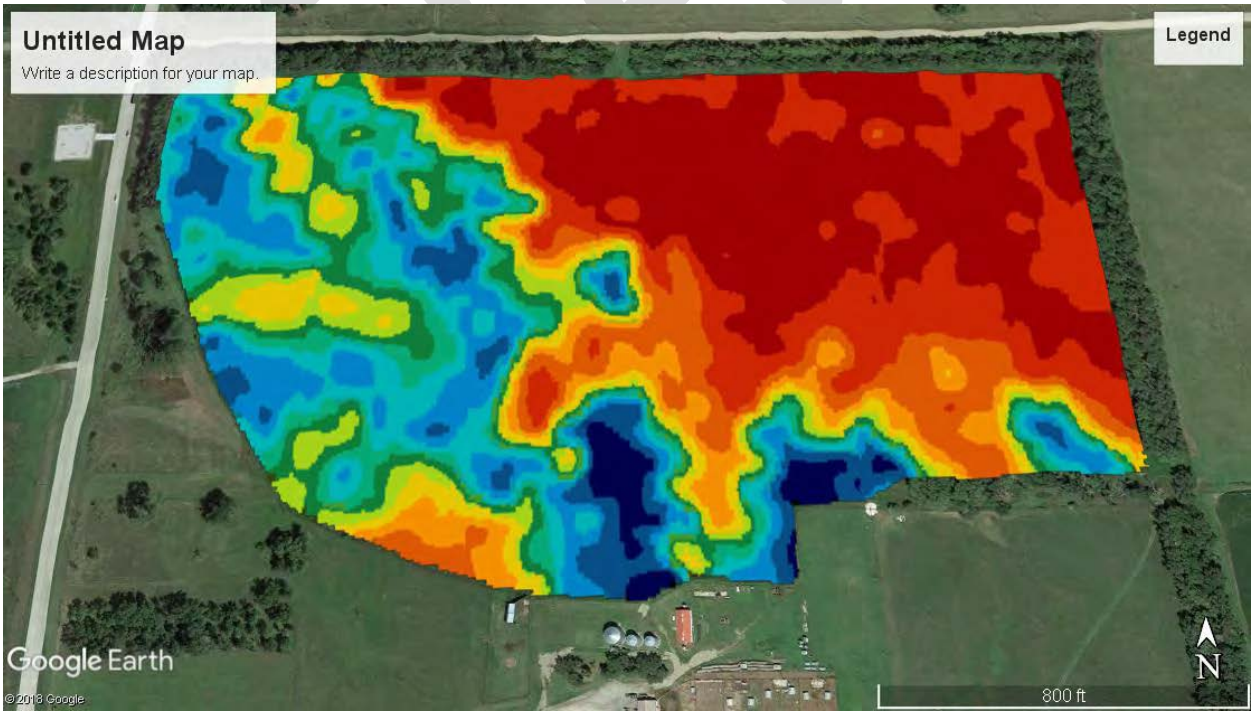
Yield Map



Subsoil Moisture Map



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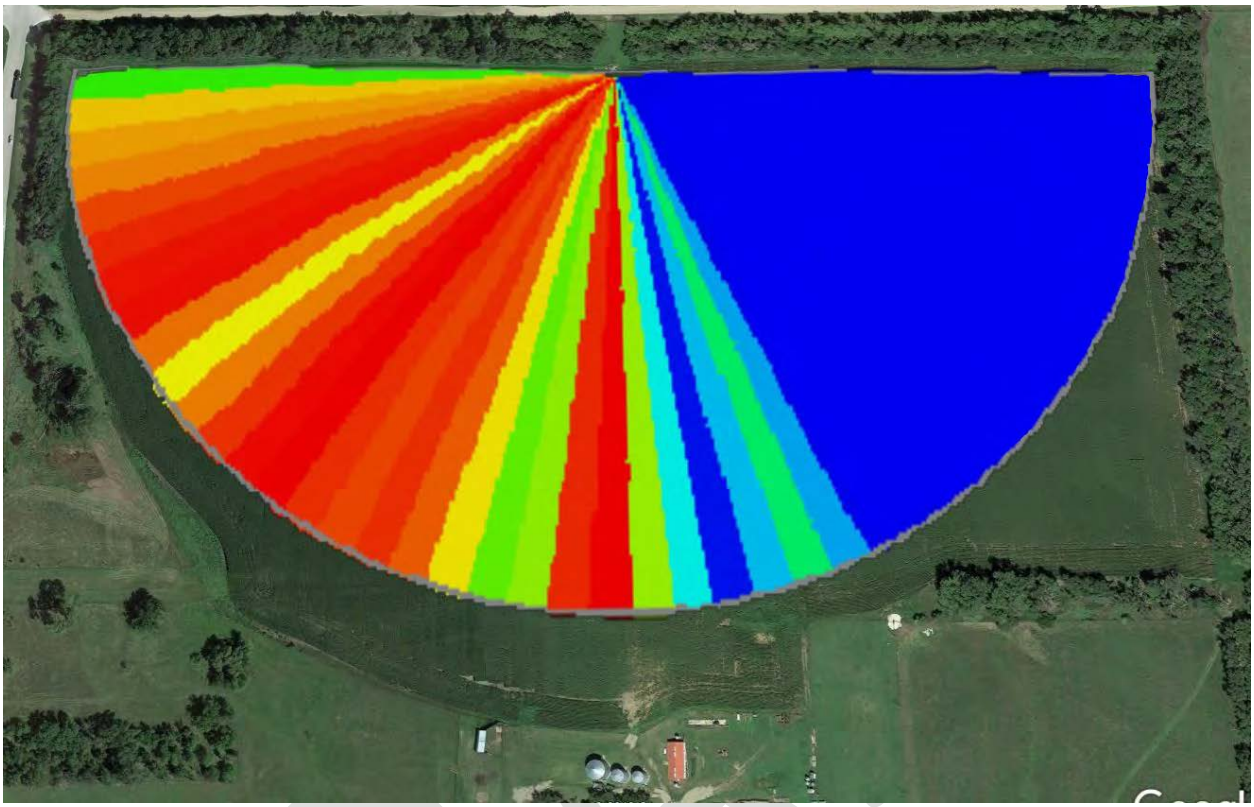
Irrigation Application Map



Look at the last 2 maps. What can you tell me about the decisions that were made based on what you can see?

Pros and Cons of Using Precision Agriculture

Pros

Get more information about the operation

Make better informed decisions

GPS allows fields to be surveyed with ease

Yield and soil characteristics can be mapped

Non-uniform fields can be subdivided into smaller plots according to their specific requirements

Provides opportunities for better resource management

Could reduce waste and increase profitability

Minimizes the risk to the environment by reducing nitrate leaching and runoff

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Cons

will take several years to gather the data needed to fully implement the system

steep learning curve to analyze data

data analysis is a time consuming project

Working with so much data can be daunting

Initial investment may be high

What others can you come up with?

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Additional Resources

Innovator walks through history of precision agriculture – Fam Industry News
http://www.farmindustrynews.com/technology/innovator-walks-through-history-precision-agriculture

The Unlikely History of the Origins of Modern Maps - SmithsonianMag.org
Read more: https://www.smithsonianmag.com/history/unlikely-history-origins-modern-maps-180951617/#bzzDxHE6aK6Jzt1H.99

Global Positioning System History – NASA
https://www.nasa.gov/directorates/heo/scan/communications/policy/GPS_History.html

What happens when Garming Goes High-Tech: National Geographic:
https://www.youtube.com/watch?v=tbkTi3zNN9s

Becs Hulti-Row Width, Multi-Hybrid Planter:
https://www.youtube.com/watch?v=bb7QZ9SsHTw

JohnDeere ExactEmerge Virtual Tour:
https://www.youtube.com/watch?v=XebeXoHOI_0

Precision Farming Key technologies and concepts: http://cema-agri.org/page/precision-farming-key-technologies-concepts

Precision Seeding: Higher yields with less seeds: http://cema-agri.org/page/2-precision-seeding

A brief history of GPS – PCWorld https://www.pcworld.com/article/2000276/a-brief-history-of-gps.html

www.GPS.gov

How GPS Works Video https://www.youtube.com/watch?v=IoRQiNFzT0k

https://www.youtube.com/watch?v=04VK5XscxB4

Precision Agriculture for livestock: Precision Livestock Farming (PLF): http://cema-agri.org/page/5-precision-livestock-farming

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