Precision Agriculture

What does it REALLY mean?

A overview of Precision Agriculture literature

How Old is Precision Agriculture?

Precision Agriculture can be considered to be hundreds of years old as any adaption to current farming practices; in order to produce more with less input; would be considered to be “precision” agriculture. Some examples would be:

- Native Americans teaching pilgrims how to add organic material to their corn plants
- The move from horses to tractors
- The introduction of bulk milk tanks versus the can

In the last 20 + years

(Courtesy of U.S. Department of Agriculture, Agricultural Research Service)

Fundamental concept : collecting data and making decisions based on that data, has been around for many years in paper form.

This was easier to do without technology on small plots. But as the size of farms grew, this no longer was possible. The larger farms require new techniques and tools. [1]

- In the 1960s and 1970 the Geographic Information System (GIS) was one of the first precision farming tools developed however it was used mainly by research institutions.
- In late 1980s the tool to tie all these together was the Global Positioning System (GPS). GPS receivers were used to determine location.

"Now what do we do with it?"

In the infancy of precision farming, early adaptors of precision farming in the late 1980s and early 1990s faced many obstacles: lack of understanding, lack of support, equipment that was still in the process of development, and inefficiencies of design.

- First technology used by innovators was yield mapping, which combined GPS and yield monitors. This was followed closely by grid sampling, which used GPS to record soil sample points. Then created the technology to create field maps that showed patterns of growth and yield.
- Experts said collect 10 years of data and then we will use it – however we didn't have answers on what to do with it.

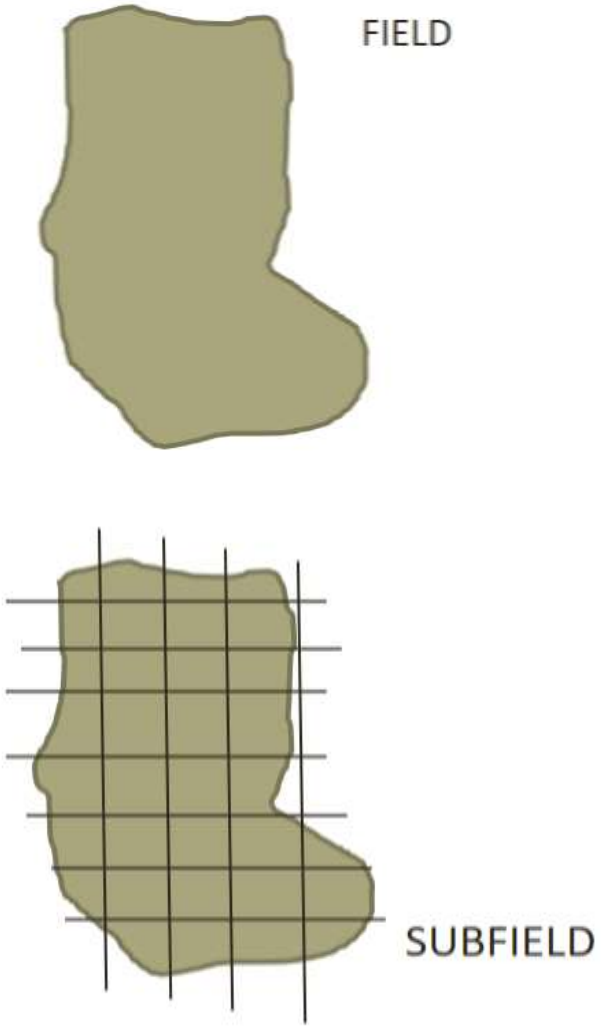
What is the definition of Precision Agriculture?

Precision agriculture (PA) or **satellite farming** or **site specific crop management** (SSCM) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. [2]

Described as site specific farming or farming by the foot.Ability to collect data and make decisions in smaller areas than an entire field .In the past farmers collected the data and averaged the entire field (average bushels or product per acre) with the assumption that the entire field had the same value

- Currently we have the ability to mark off/identify a small area of a field or a subfield.
- **Five areas of interest in Precision Agriculture include: subfield, variability, technology, efficiency, benefits**

What is a subfield?



- A smaller portion of a field (dissect out smaller areas of a field)
- Allows for more precise and accurate decision making
- Farmers are able to make decisions based on information from that area
- Not all decisions are appropriate in other areas

Variability

Variability can be found in all fields and can be seen in soil fertility, moisture content, soil texture, topography, plant vigor, and pest populations.

Spatial variability is the range of difference or variation in soil composition, crop yield or insect population, and environmental characteristic over distance and depth.

Temporal variability is the variation in crop, soil, and environmental characteristic over time. [3]

Spatial variability is the driving force behind Precision Agriculture .Without variability you do not have a reason to subdivide fields. Allows you to implement management practices specific to each subfield.

Soil types define much of the variability within a field

Efficiency

In the past, it was difficult for farmers to correlate production techniques and crop yields with land variability. This limited their ability to develop the most effective soil/plant treatment strategies that could have enhanced their production.

Today, more precise application of pesticides, herbicides, and fertilizers, and better control of the dispersion of those chemicals are possible through precision agriculture, thus reducing expenses, producing a higher yield, and creating a more environmentally friendly farm. [4]

Management Efficiency is the ability of the producer to use Precision Ag Technology for fundamental management of the operation

Decision Making Efficiency is the ability to use financial and production records to make decisions such as:

- No till vs. conventional tillage
- Which crops give higher return?

- The most common case for increased efficiency is variable application of fertilizers/chemicals

Variable Application

Farmers identify the variability within each field then use variable applications systems in order to deal with the specific variances within the field.

Variable rate application, originally used for fertilizer application on large custom applicators, is now being used in: side dressing fertilizer, foliar application, manure application, and in combination with on-the-go soil monitoring equipment.

Possibly the most unique way of using variable rate is with unmanned aerial vehicles (UAV) or drones. These vehicles are useful for in-field use to remotely capture images of plant stress, process images into variable rate application maps, and control by GPS to spray only those areas that need it.[5]

Variable rate application – specified amounts of product in certain areas

- The goal is to have 100% of the field having the correct amount of product.
- Broadcasting the same amount is inefficient

Technology

There are many innovative products, tools, and processes that are available to farmers to use in the management of their acres. Those systems include: [5]

- ***Guidance Systems*** - the cost of the light bar and GPS provides savings from the accurate placement of rows.
- ***Variable Rate by Formula and by Remote-Sensed Data*** - There are services now available that will determine a variable rate fertilizer application based on remote-sensed images that measure moisture & nutrients in soil.
- ***Data Collection*** – GPS units are getting smaller,more compact& integrated. GPS provides flexibility & ease of use in collection of spatial data.
- **Sensor web -C**onsists of a group of wirelessly connected sensors that form a web throughout an area of interest.Sensors can be programmed to collect humidity, temp. environmental attributes.
- ***Spatial analysis*** - Software programs provide analysis capabilities for the data that they have collected.
- ***Data collection, data analysis, and implementation = Precision agriculture***

Benefits

Cost savings is the biggest benefit of using precision ag products.

Producers believe that the cost of the light bar and GPS provides savings from the accurate placement of rows. Comments from producers indicate that the savings in chemicals and seed has meant a one-year to two-year payback.[5]

Environmental Benefits – ability to reduce or strategically place inputs or make decisions that will reduce impact on natural resources

- Terraces, buffer strips, products at lower rate
- Economic Benefits – decisions that result in higher monetary return
- Lower operating cost = more income

What are the tools of Precision Agriculture?

Global Positioning System . . . GPS

- GPS can now be connected to handheld computers through compact flash ports, secure digital ports, or even wirelessly. Tablet computers, hardened covers, or handheld computer devices come with data collection software.
- Wireless connections to the Internet in the field allow real-time download of aerial images or other data. This all increases the ease of use and robustness desired by the early majority.

- Geographic Information Systems . . . GIS
- Intelligent Devices and Implements . . . IDI
- Remote Sensing
- Computers

DEFINITION

➢Precision agriculture or Precision farming also known as site-specific management refers to the practice of applying agronomic inputs across a farm, mainly fertilizers and other chemicals, at variable rates based on soil nutrients or chemical tests, soil textural changes, weed pressures and yield maps for each field in the farm.

WHY PRECISION AGRICULTURE

➢High cost of crop inputs including seed, fertilizer, pesticides and fuel

➢Environmental concerns about fertilizers and pesticides near sensitive areas, runoff and de-nitrification

➢The technology has become available and economically feasible

MANY NAMES OF PRECISION AGRICULTURE

➢Precision farming , GPS farming, Prescription farming ,Farming by satellite, Spatially variable agriculture ,Farming by the foot,Site specific management ,Variable rate application

BASIC COMPONENTS OF PRECISION FARMING

- Precision farming depends on measurement & understanding of variability, the main components of precision farming system must address the variability.
- Precision farming technology enabled, information based & decision focused, the components include, RS, GIS, GPS, Soil Testing, Yield Monitors & Variable Rate Technology.

APPLICATION OF REMOTE SENSING IN PRECISION FARMING

- a potential tool in providing spatial & temporal information on soil & crop variables which could be related with crop growth and yield models.
- The kind of information on soil and crop variables largely depends on the remote sensing platforms and the remote sensors.

APPLICATION OF GIS IN PRECISION FARMING

- GIS combines different kinds of data (map, tables, digital data and point data). It integrates layers of information about to give better understanding of that place. GIS requires suitable software for the data analysis and integration.
- Invaluable tool in planning and monitoring of natural
- resources like soils, lad use etc., at a regional or national level.
- Decision making tool in agriculture.
- It can take in to account of soil fertility, gradient of lands, annual rainfall, availability of rural labour and access to markets.

APPLICATION OF GPS IN PRECISION FARMING

The advent of GPS allowed for low-cost, reliable positioning of equipment in the field. Data from other sensors could be tied to a specific point in the field with precision

Role of GPS in precision agriculture:

- Yield mapping
- Variable rate control
- Field mapping
- Asset tracking
- Irrigation
- Tracking livestock
- Aerial spraying
- Autosteering
- Automatic section control
- Drainage
- Guidance

STEPS IN PRECISION FARMING

The basic steps in precision farming are,

i. Assessing variation
ii. Managing variation and iii.Evaluation

Assessing variability is the critical first step in precision farming.

➢Since it is clear that one cannot manage what one does not know. Factors and the processes that regulate or control the crop performance in terms of yield vary in space and time.

➢ Quantifying the variability of these factors and processes and determining when and where different combinations are responsible for the spatial and temporal variation in crop yield is the challenge for precision agriculture.

MANAGING VARIABILITY

- Once variation is adequately assessed, farmers must match agronomic inputs to known conditions employing management recommendations.
- Those are site specific and use accurate applications control equipment.
- For successful implementation, the concept of precision soil fertility management requires that within-field variability exists and is accurately identified and reliably interpreted, that variability influences crop yield, crop quality and for the environment. Therefore inputs can be applied accurately.

The higher the spatial dependence of a manageable soil property, the higher the potential for precision management and the greater its potential value.

The degree of difficulty, however, increases as the temporal component of spatial variability increases.

Applying this hypothesis to soil fertility would support that Phosphorus and Potassium fertility are very conducive to precision management because temporal variability is low. For N, the temporal component of variability can be larger than its spatial component, making precision N management much more difficult in some cases.

EVALUATION

There are three important issues regarding precision agriculture evaluation

1.Economics,

2. Environment

3. Technology transfer

Objectives

Promotion of new venture in the 'Agriculture and its allied sector' bringing together various component of agriculture to exploit the variability

Reduction in cost of cultivation due to site-specific crop management practices

Increase in production efficiency of inputs due to site-specific management of inputs

Reduction in soil and environmental pollution

Reduction in the application of nutrients especially nitrogen fertilizer thus reducing nitrate in underground water and nitrous oxide to the atmosphere

Reduction in chemicals does through variable rate application technology

Reduction in the application of irrigation water thus reducing of nutrient along with deep percolations

Reducing erosion, runoff and sedimentation of water bodies

Resources

1. History of Precision Ag http://www.delmarlearning.com/companions/content/140188105X/trends/history_pre_agr.asp
2. Excerpts were taken from Wikipedia http://psstldemo3.esri.com/apps/storytelling_AgFive/ Text is available under the Creative Commons Attribution-ShareAlike License
3. Agricultural Primer, The Precision-Farming guide for Agriculturists, Deere & Company
4. GPS.gov http://www.gps.gov/applications/agriculture/
5. New Technologies, Tools, and Techniques http://www.delmarlearning.com/companions/content/140188105X/trends/new_tech.asp