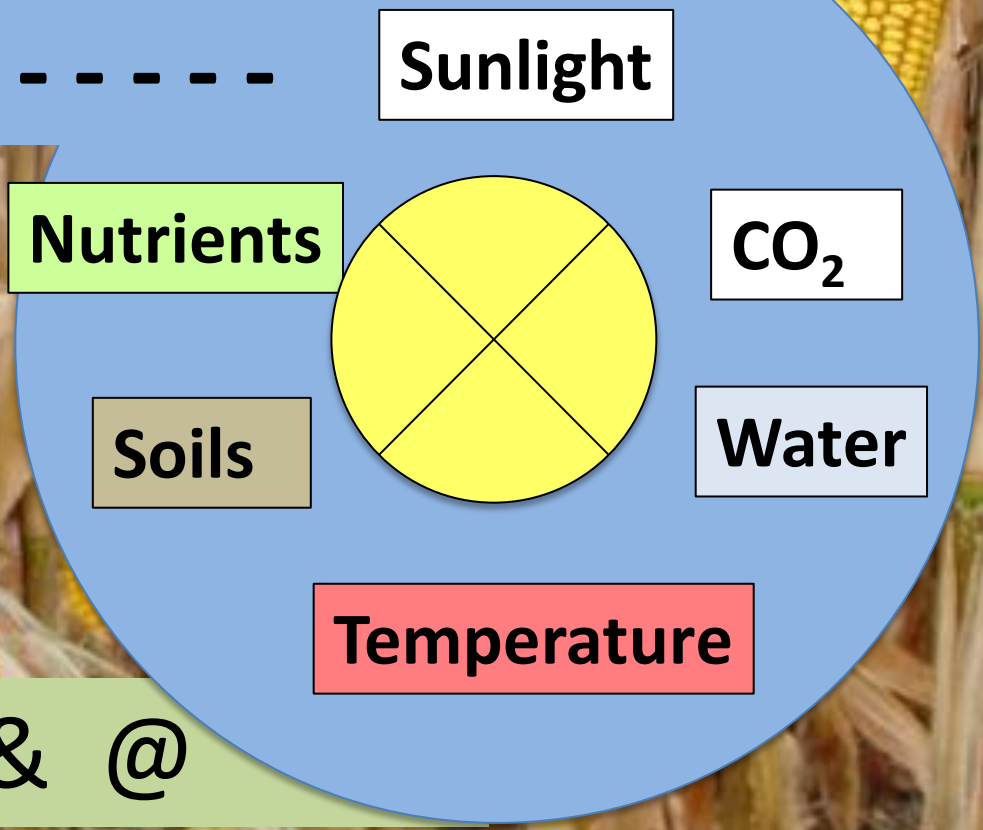
Crop Yield and N Management Models - - - - - -



Pitfalls

Promises

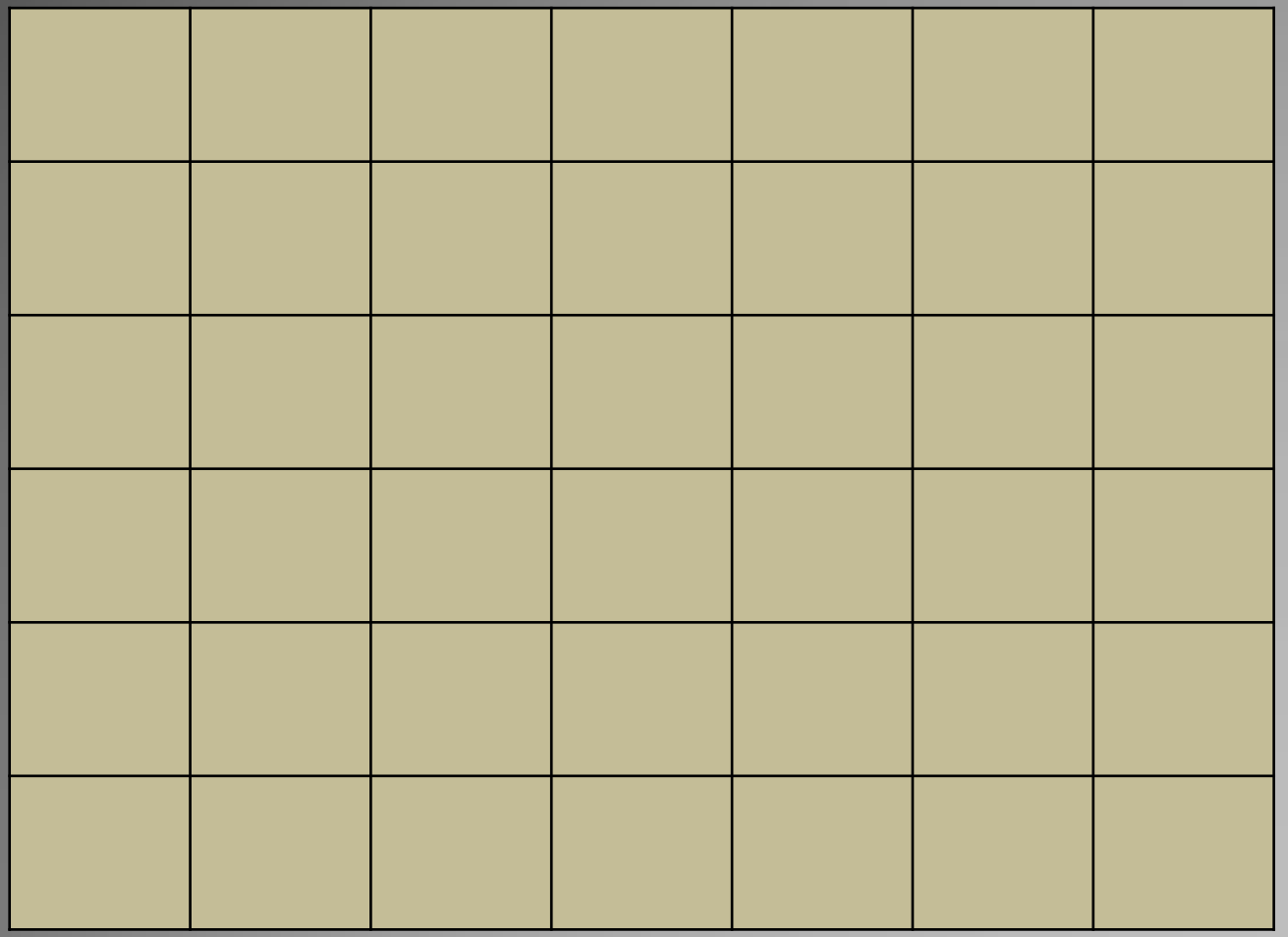
$ % & @

Jim Schepers

Nutrient Management

Vendors

Considerations



Commercial Management Products

DuPont Pioneer “Encirca^{SM} Yield”	*genetics*
Monsanto Climate Corp “Nitrogen Advisor”	*genetics*
Adapt-N	*software*
WinField “R7 Tool”	*resch/advisory*
Western Ag	*consulting*
Farmer’s Edge	*consulting*
ServiTech	*consulting*
Beck’s Hybrid “FARM Server”	*genetics*
Yield 360 Center	*tools/devices*
SatShots	*imagery*

Goal

Climate

Soil

Water Processes

Models

Hybrid Selection

Yield Maps

Tissue Testing

Remote Sensing

Previous Crop

Residual N

Field Level vs. Spatial Nutrients

Cultural Practice Tools

In-Season Advice

Marketing (sales & purchases)

Multiple Product Sales

Web Site

Considerations

Goals

Conveniently-deliver decision support services that help growers ***increase profitability***, ***production stability***, and ***sustainability***

Solution to help ***maximizing inputs*** while ***optimizing yield***

Profit maximization, ***risk mitigation***, and ***scalable environmental benefits***

Maximize yield profitability

Optimize profitability using multiple nutrient response (N, P, K, S) curves, crop prices, and fertilizer costs

Sustainable production of ***high yielding*** and ***high quality*** crops

Goals

Optimize producer profitability by routine field inspections, by recommending and helping incorporate appropriate technologies for fertility, varieties, irrigation, tillage, weed/insect management, federal/insurance programs, etc;

Offer a simple, secure, web based program to monitor variables and collect and analyze data to ***increase productivity***

Measure and supply the right amount of N when the crop is ready to use it

Deliver "***Crop Health Imagery"*** analysis and notifications that **facilitate real-time management** and actionable variable rate application maps of fields

Climate

Class-A Weather Station

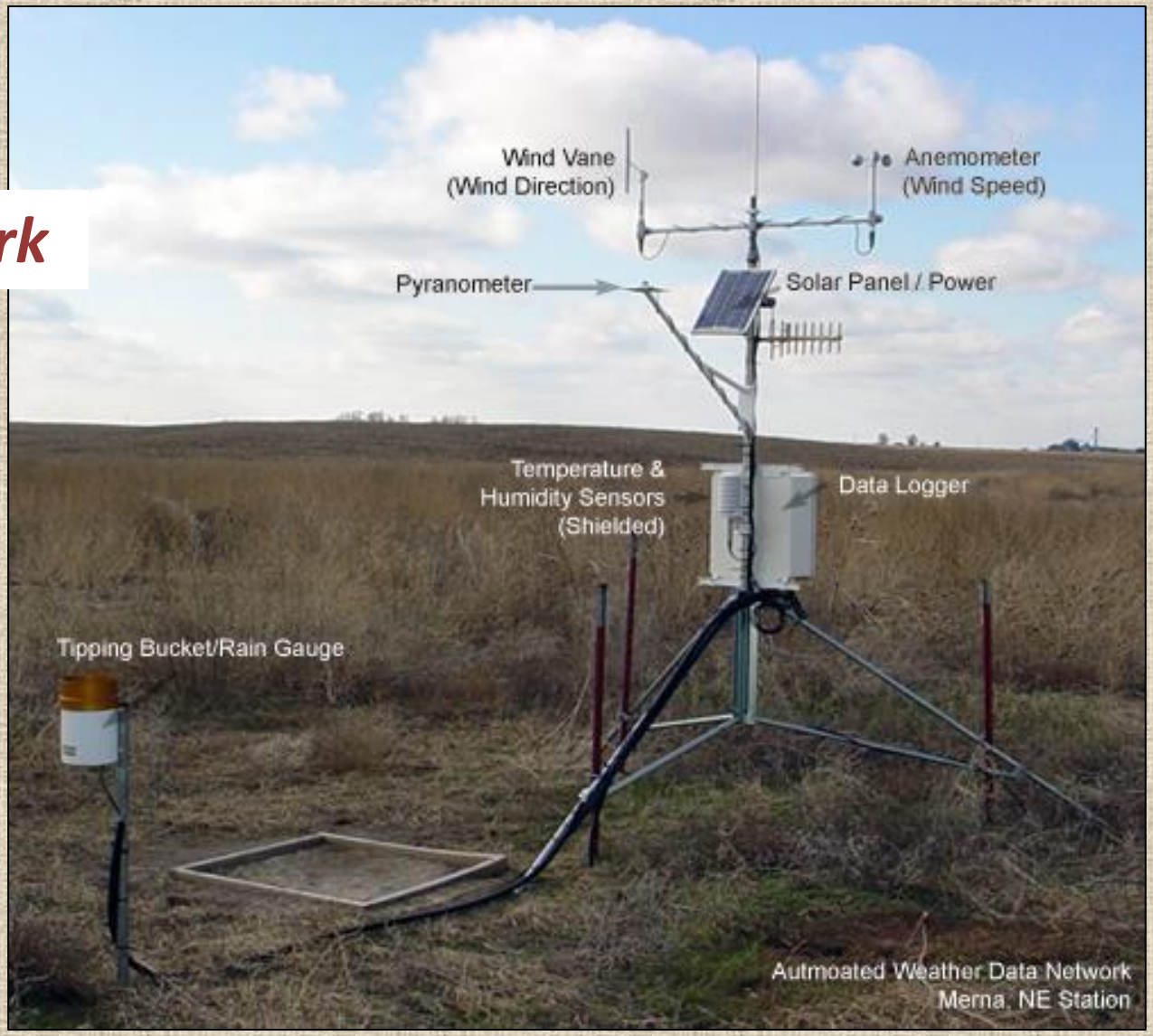
Provides long-term records

Farm Weather Data

Typical Network Weather Station

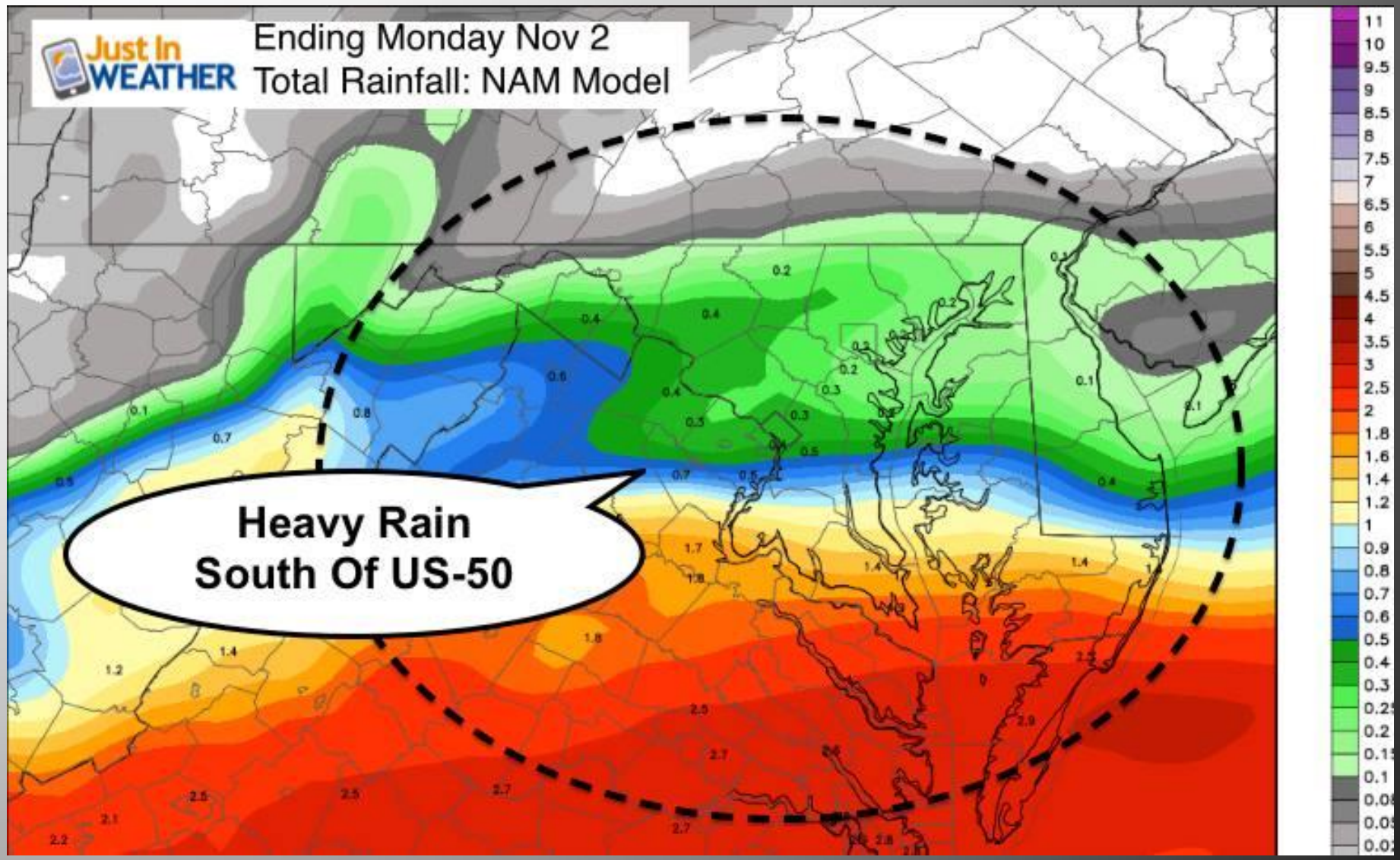
10 - State Network

"Mesonet" Stations



High Plains Regional Climate Center, Lincoln, NE (www.hprcc.unl.edu)

Simulated Precipitation Map - Example



Map based on radar data that was calibrated using rainfall records

Soils

SSURGO data base (*means* Soil Survey Geographical)

Generated and maintained by USDA - NRCS

See: websoilsurvey.sc.egov.usda.gov

Search

Area of Interest

Import AOI

Quick Navigation

Address
State and County
Soil Survey Area
Latitude and Longitude
PLSS (Section, Township, Range)

SSURGO → Automatically linked to some service providers

Water Processes

"Infiltration"

Some commercial services use models to estimate water infiltration, percolation and N losses.

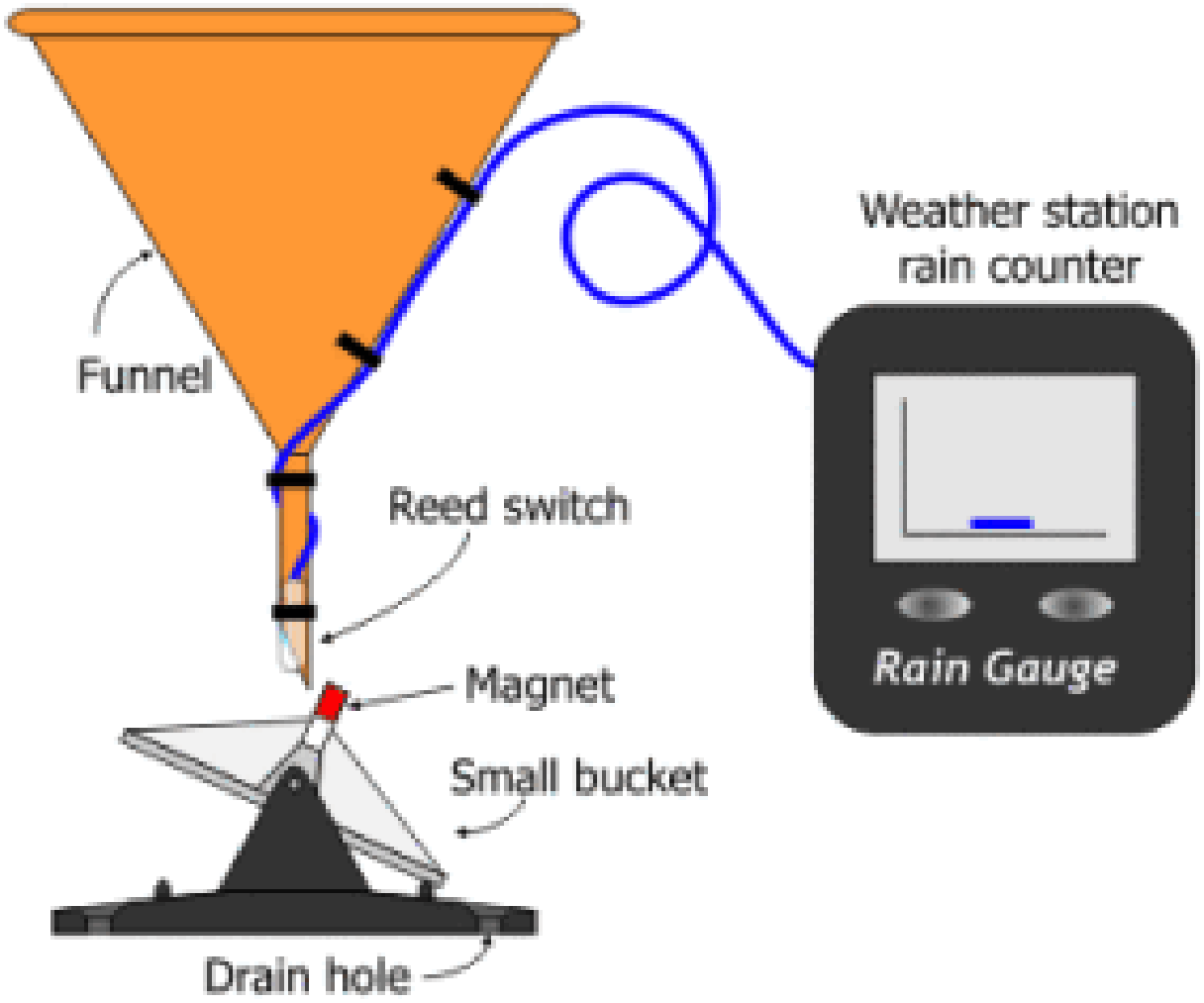
needs SSURGO soil and climatic data

most use the tipping-bucket rain gauge approach, **IF ANY**

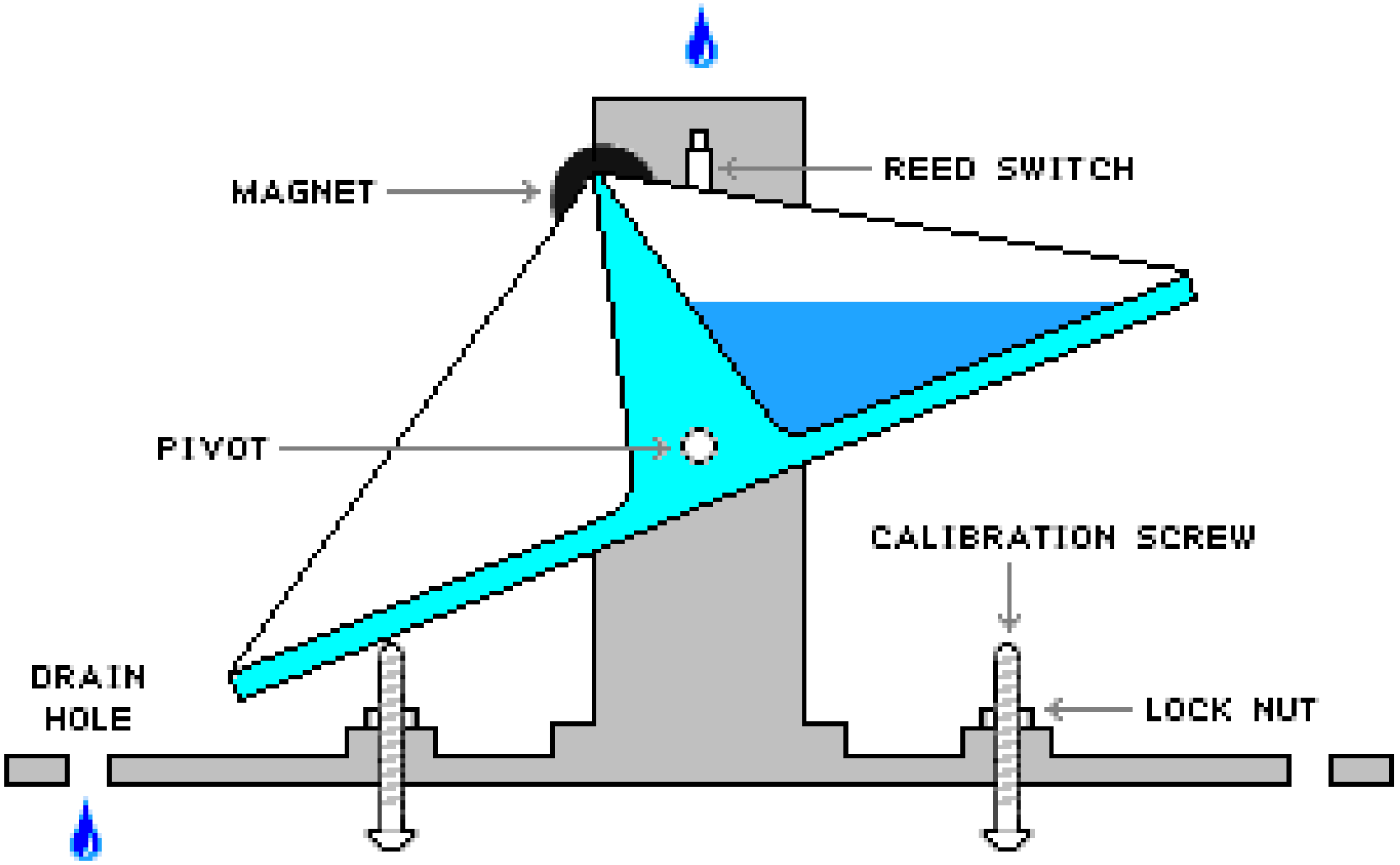
"Hydrology"

Some commercial services use models to route water across the landscape and to the edge of the field.

Tipping Bucket Rain Gauge



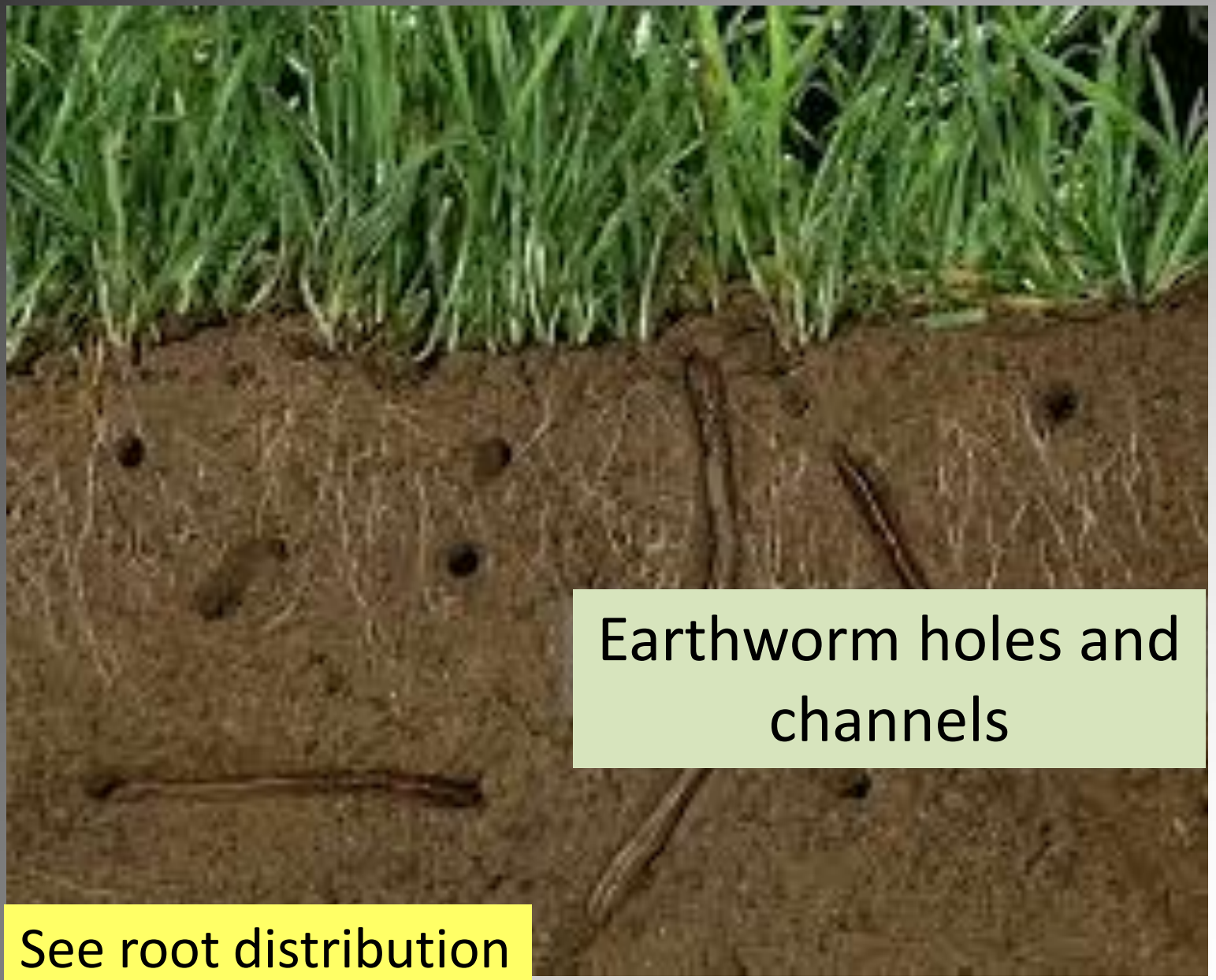
Tipping Bucket Rain Gauge



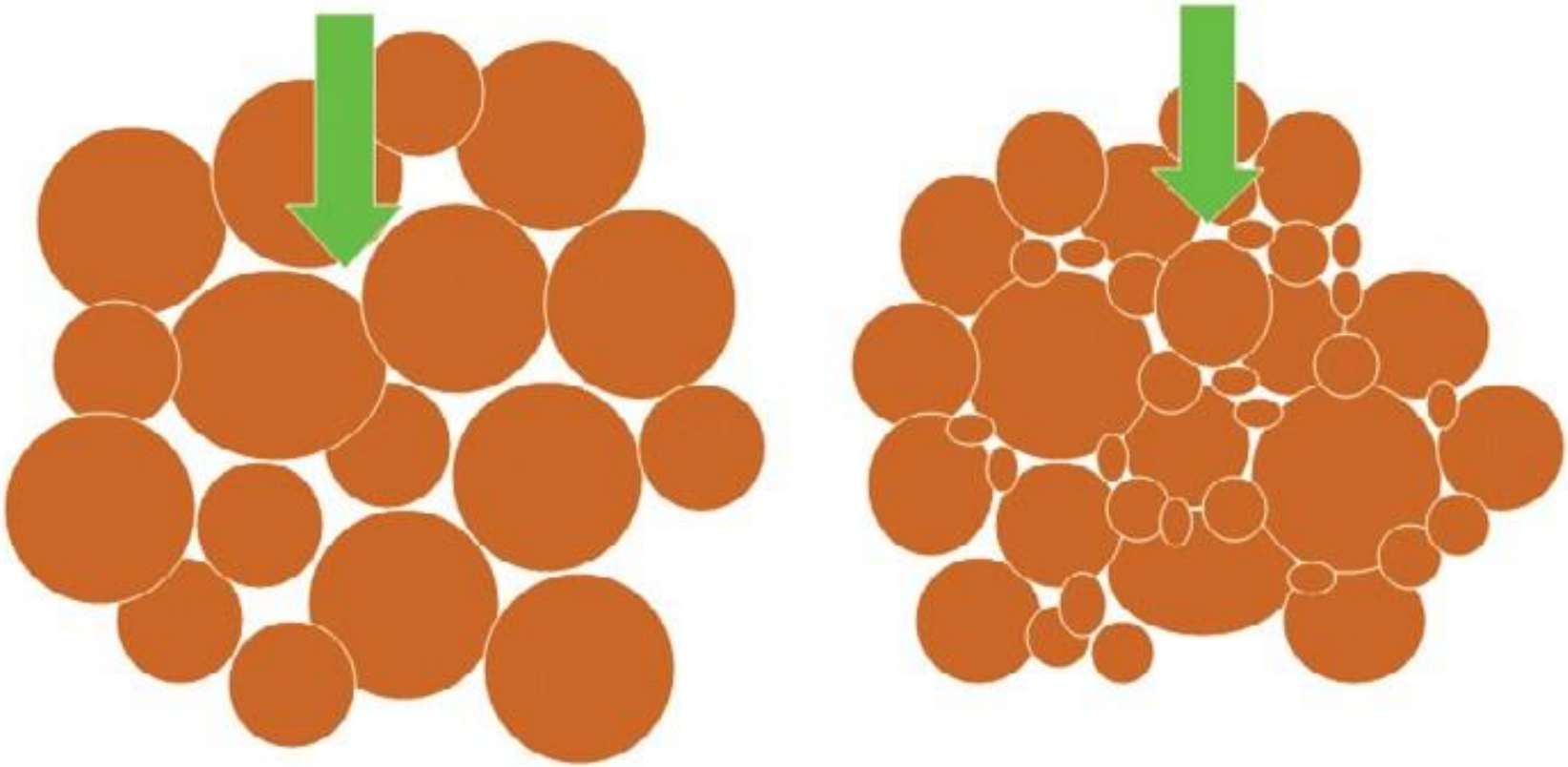
Sample of Soil Profile Variability

Samples of Soil Development

H_2O



See root distribution


LARGE
SMALL
MACROPORES
MICROPORES

Tracer Dye

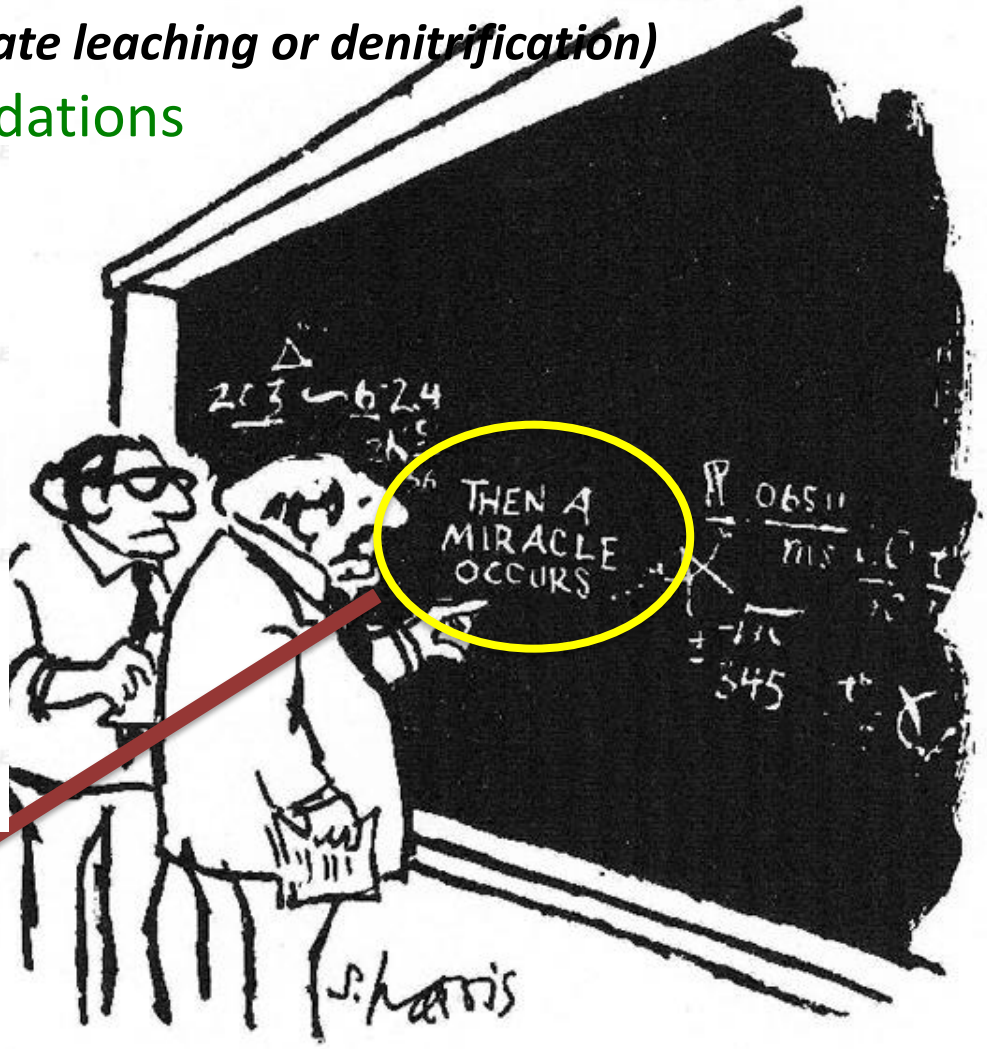
See vertical flow until water reached impeding layer

See vertical flow through dense layer via cracks and root channels

Tracer Dye

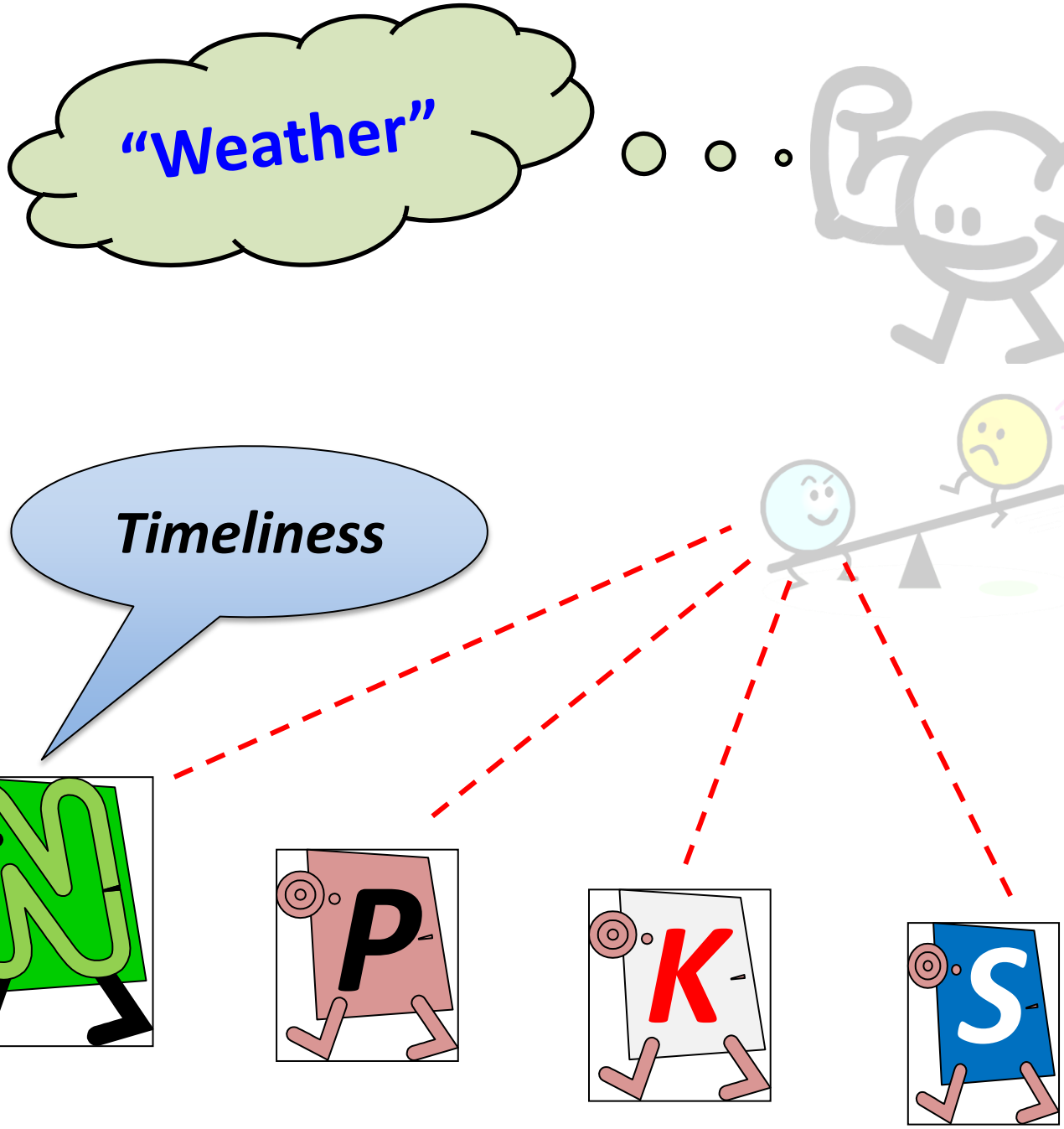
Models

Crop growth
Mineralization
N losses ***(nitrate leaching or denitrification)***
N recommendations



"I think you should be more explicit here in step two."

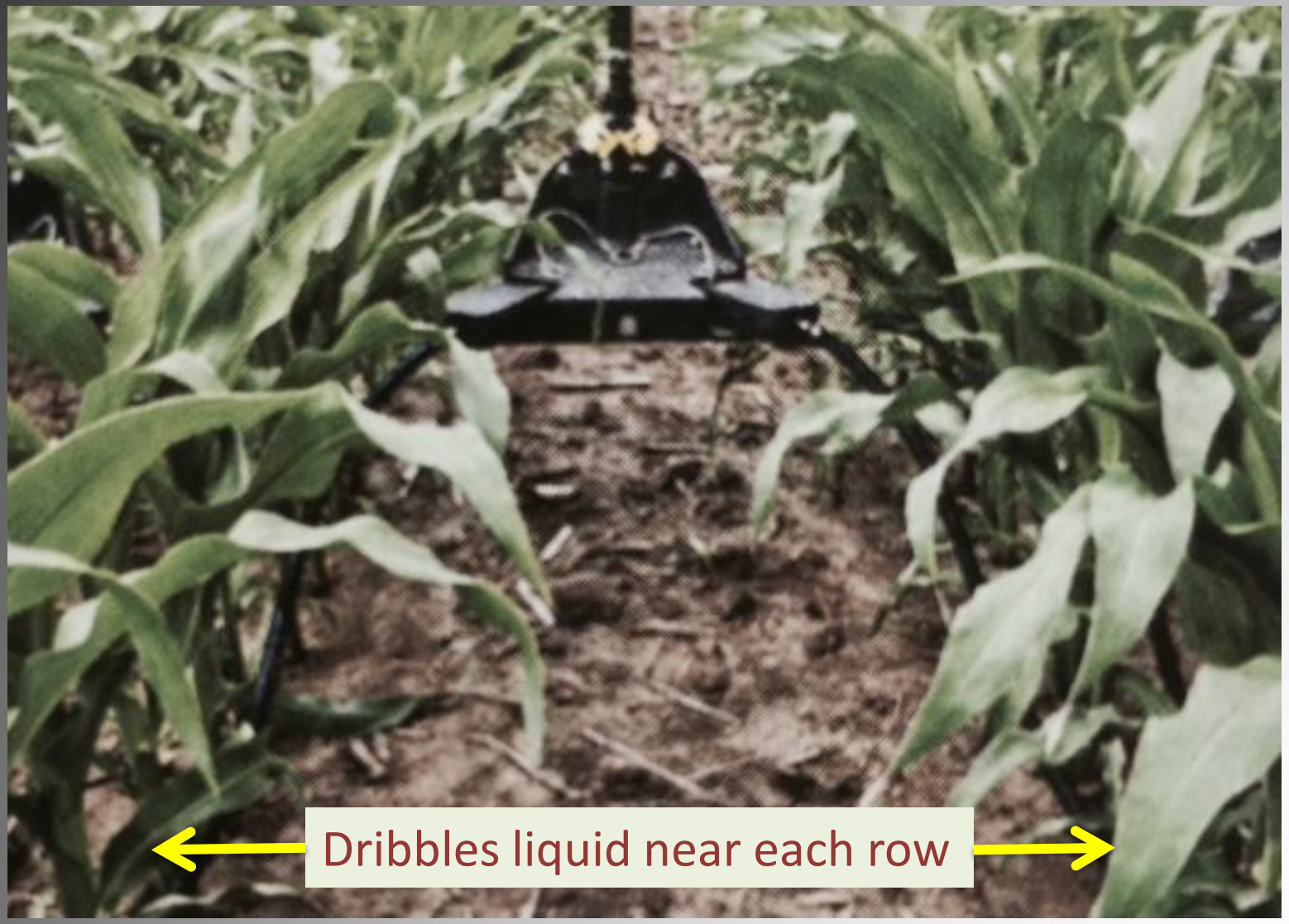
"Then a MIRACLE occurs"


"Weather"
Timeliness
N
P
K
S

Yield 360 Center - Rapid-Nitrate Test

Moist soil sample
Add distilled water
Mix well
Nitrate electrode analysis

Yield 360 Center - “Y – Drop” Applicator



Hybrid Selection

YES - - - - - - - ***Only Relative Maturity*** - - - - - - - ***NO***

Yield Maps

Most consider yield maps

Regional Yield Information

Some integrate regional yields into recommendations

Tissue Testing

Only a few use tissue testing

Considerable potential

Remote Sensing

Satellite

4 – band aircraft

Drones ? ? ?

Evolving Technology

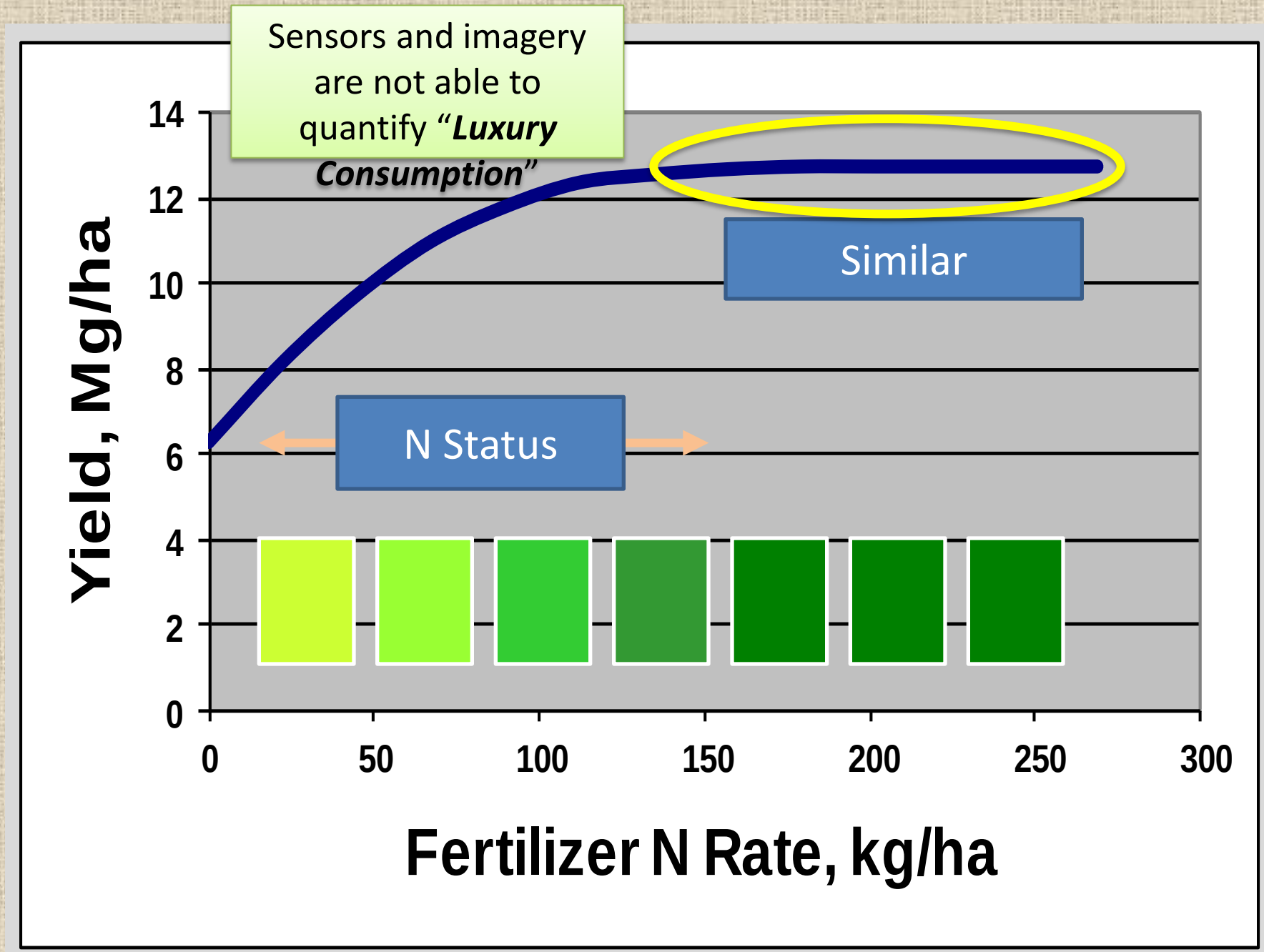
Indices

- NDVI
- NDRE
- others

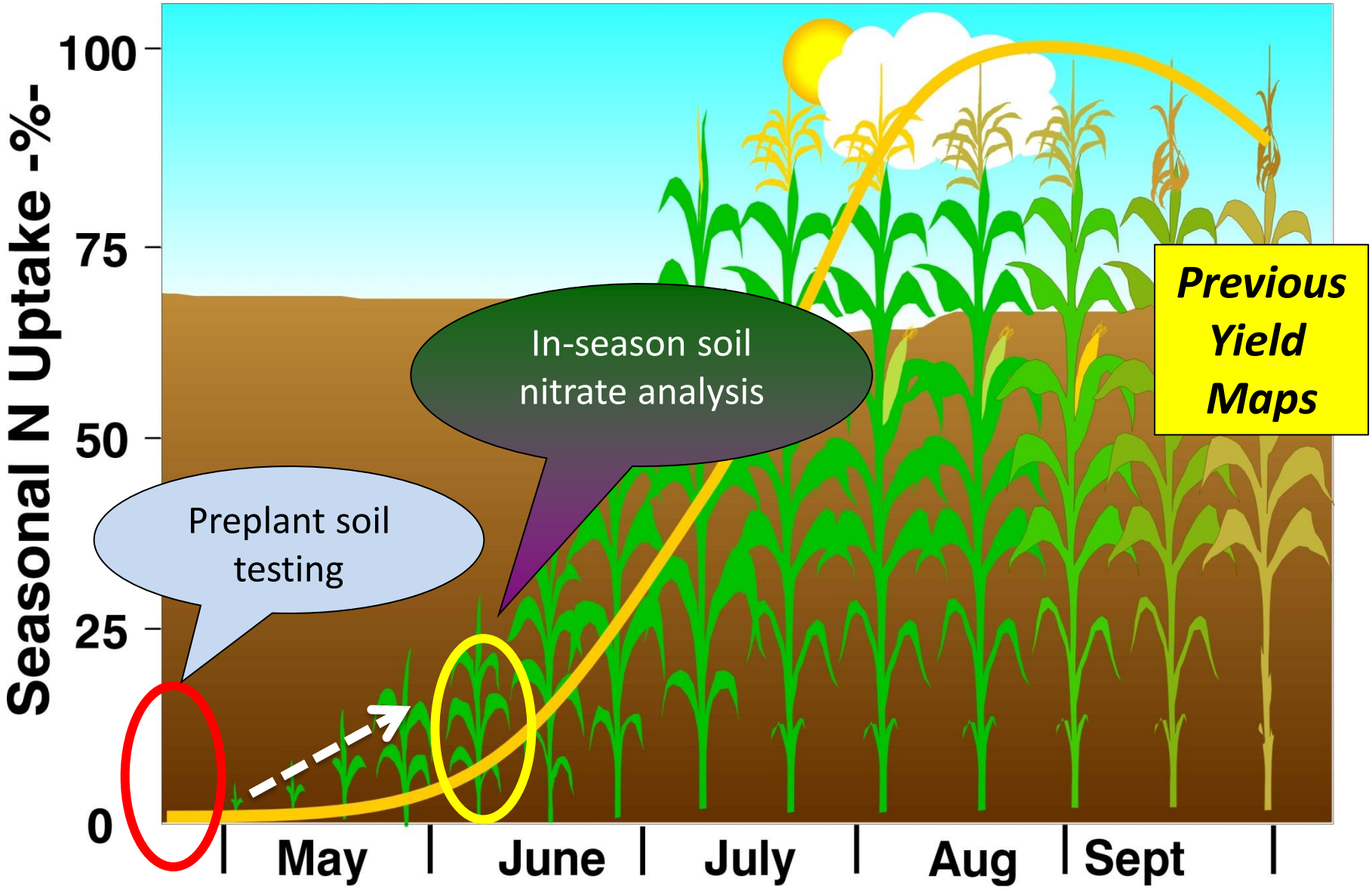
Low Hanging Fruit in 2016

"Don't fix it if it's not broken"

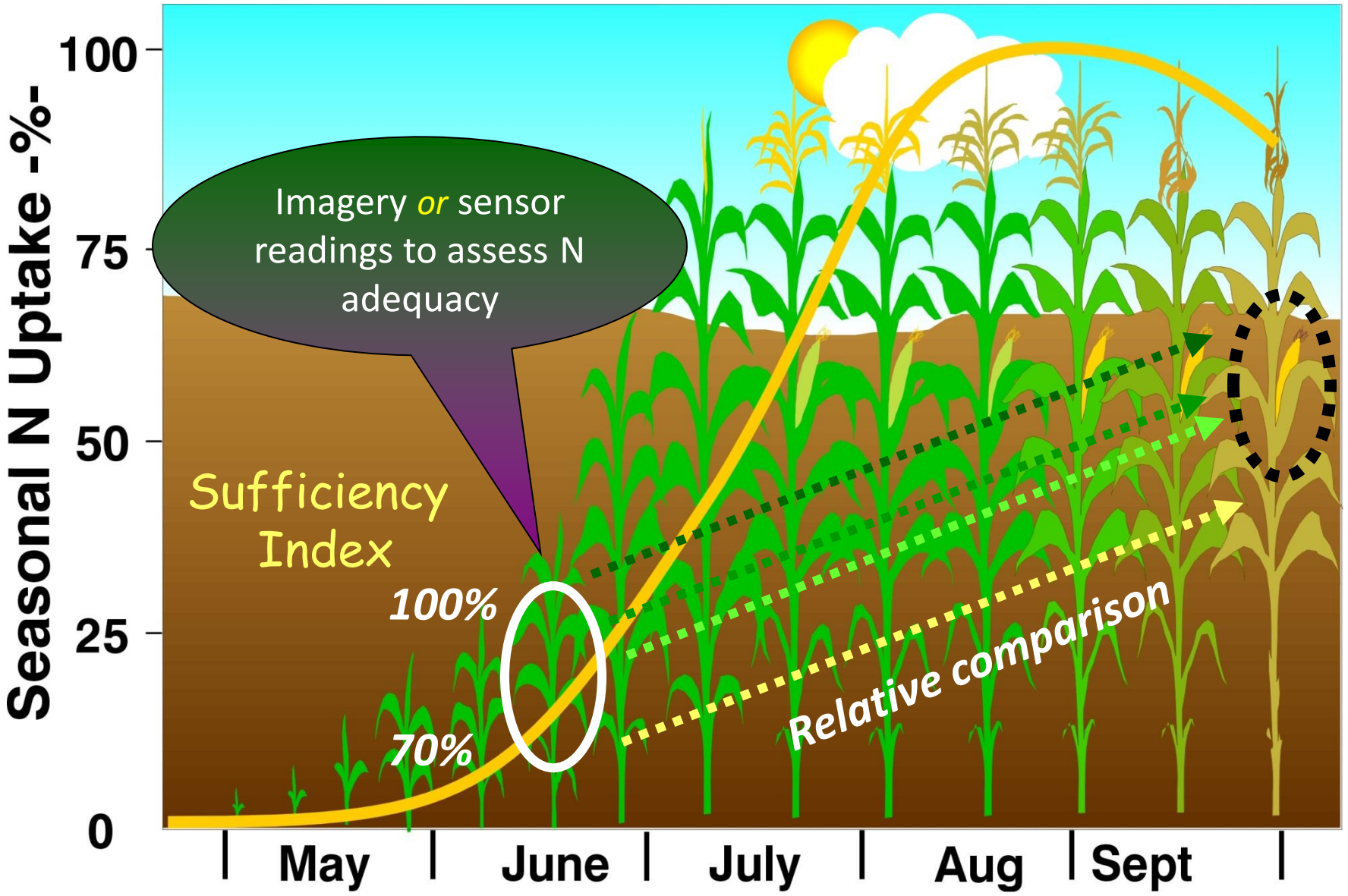
"You can't work on a solution until a problem has been identified"


Sensors and imagery are not able to quantify "Luxury Consumption"
Similar
N Status
Yield, Mg/ha
0
2
4
6
8
10
12
14
0
50
100
150
200
250
300
Fertilizer N Rate, kg/ha

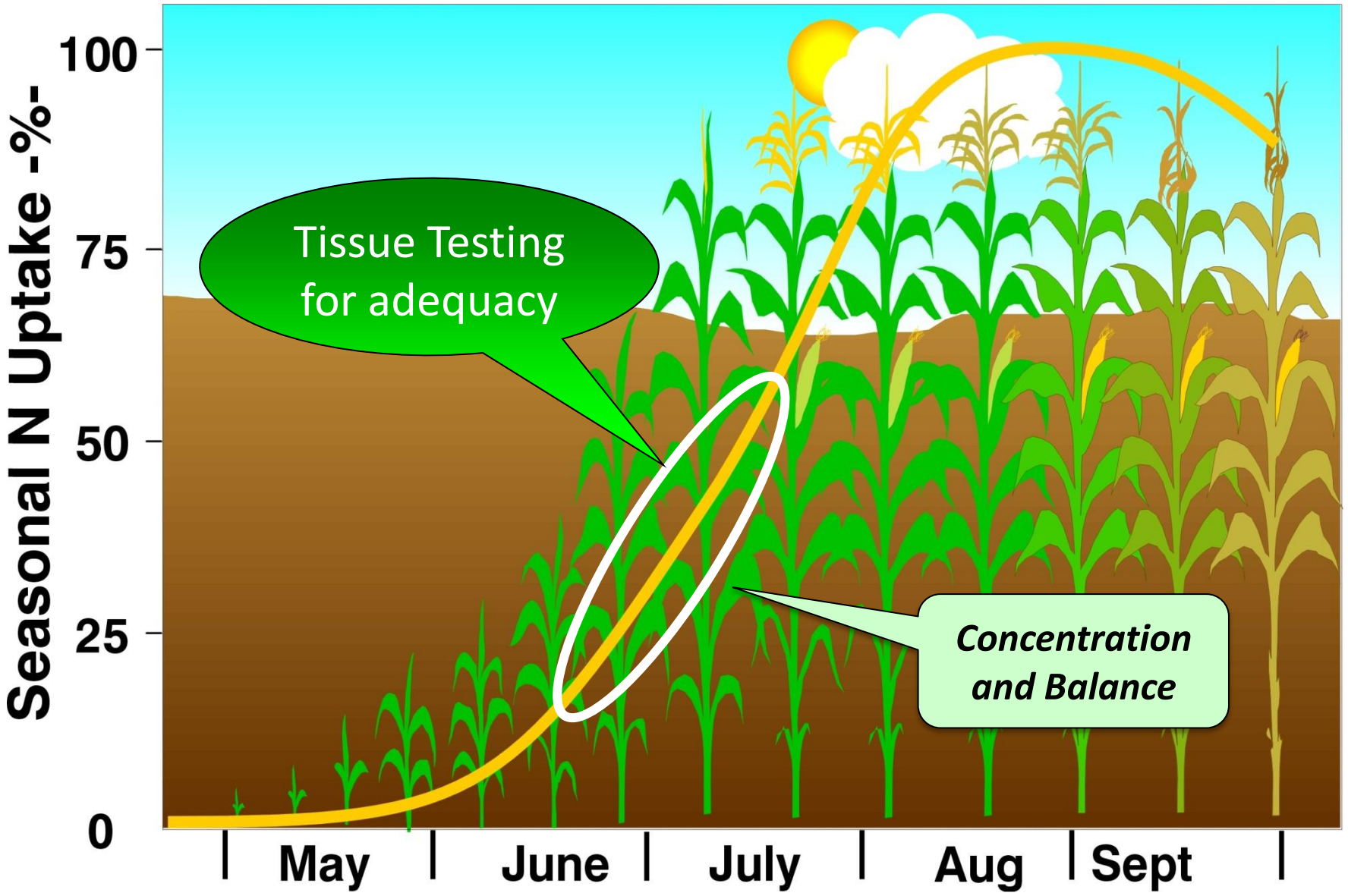
Where Does ***Adaptive Management*** *Fit ?*



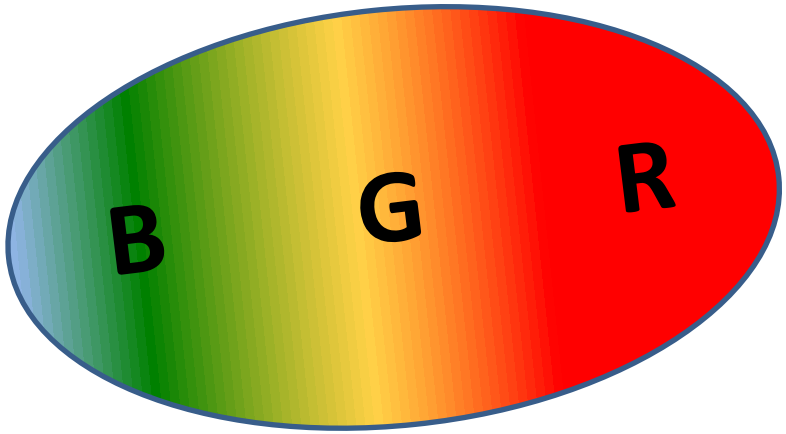
Where Does **Adaptive Management** *Fit ?*

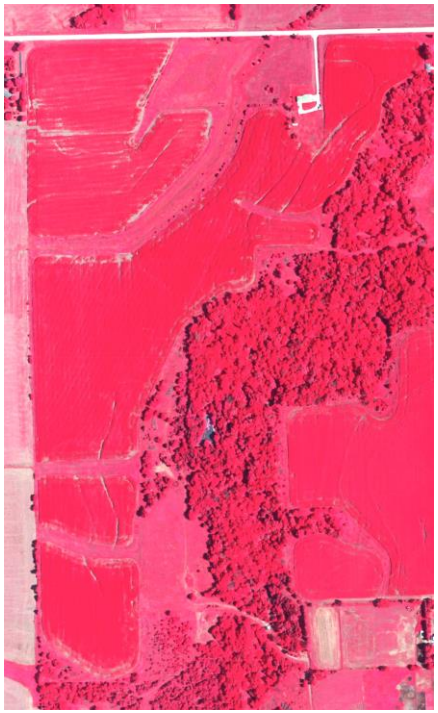


Where Does ***Adaptive Management*** *Fit ?*



Remote Sensing





John Niemeyer Field *(July 27, 2015)*

Color (R G B)

Color Infrared

John Niemeyer Field *(July 27, 2015)*

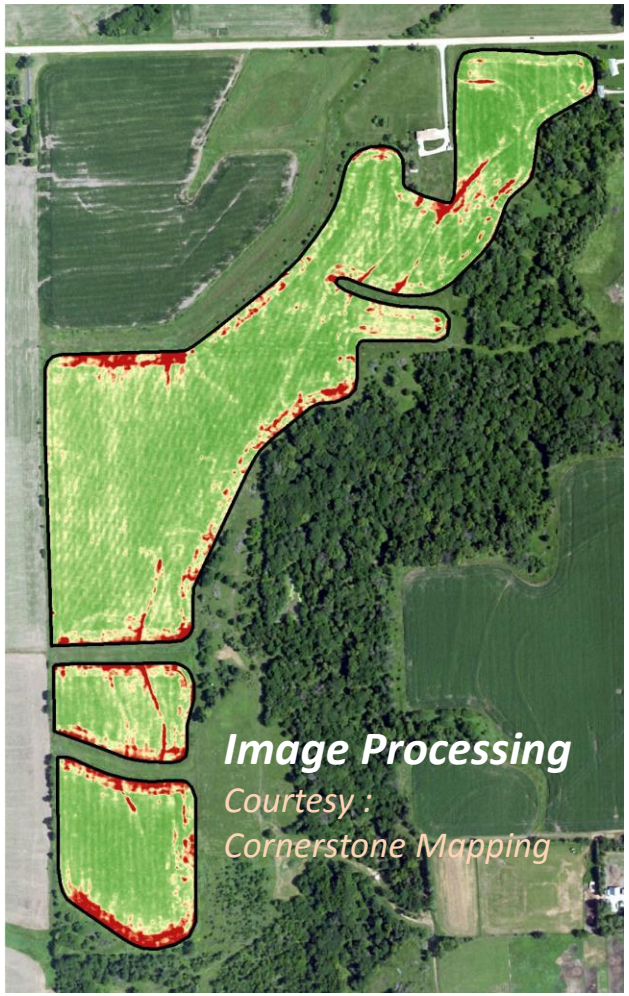
Color Infrared

Stretched Color Infrared over Color Image

NDVI

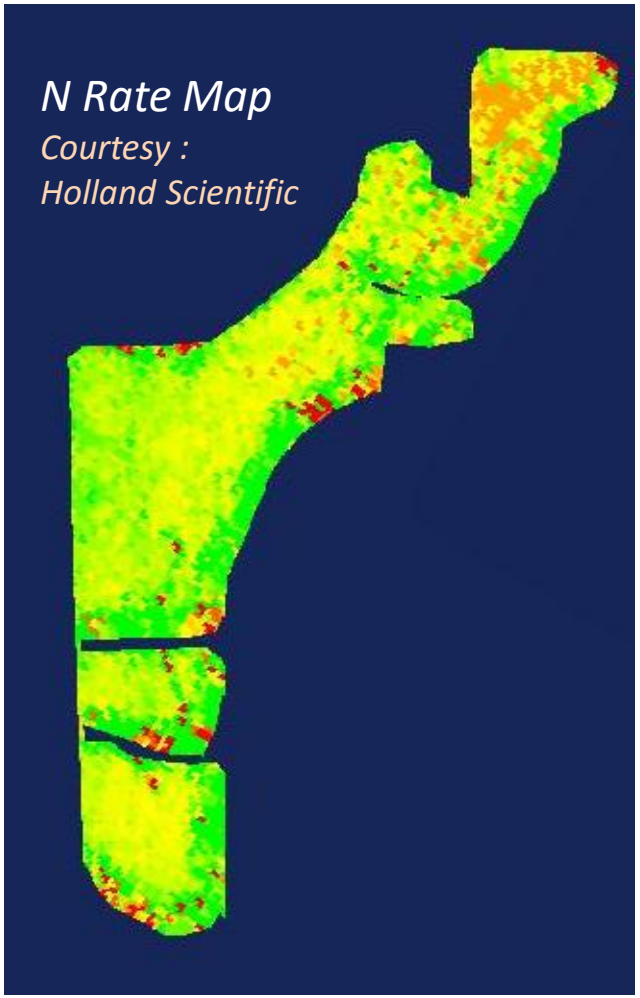
low *high*

John Niemeyer Field *(July 27, 2015)*



Management Zones

"*Real-Time*" Algorithm



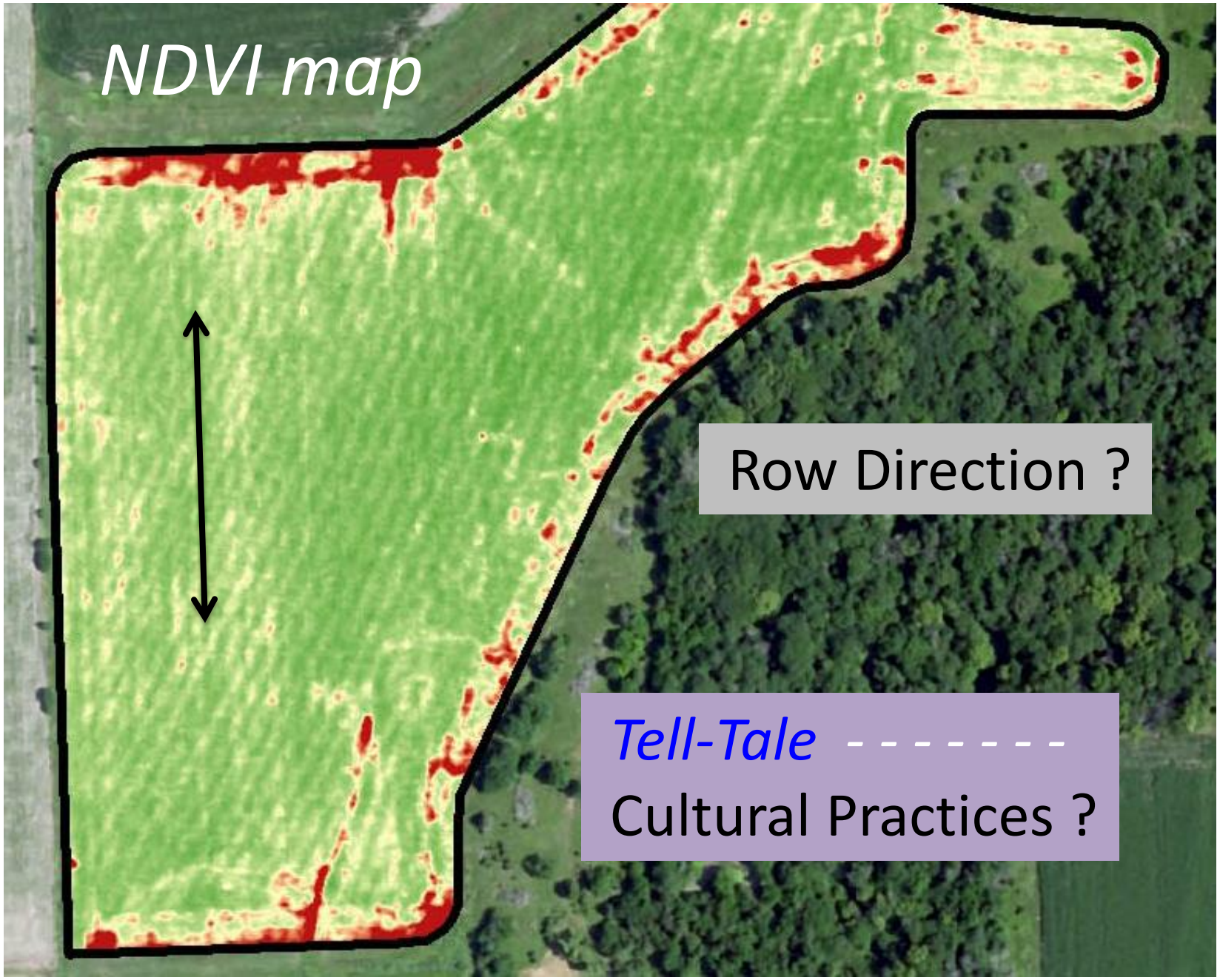
NDVI

low *high*

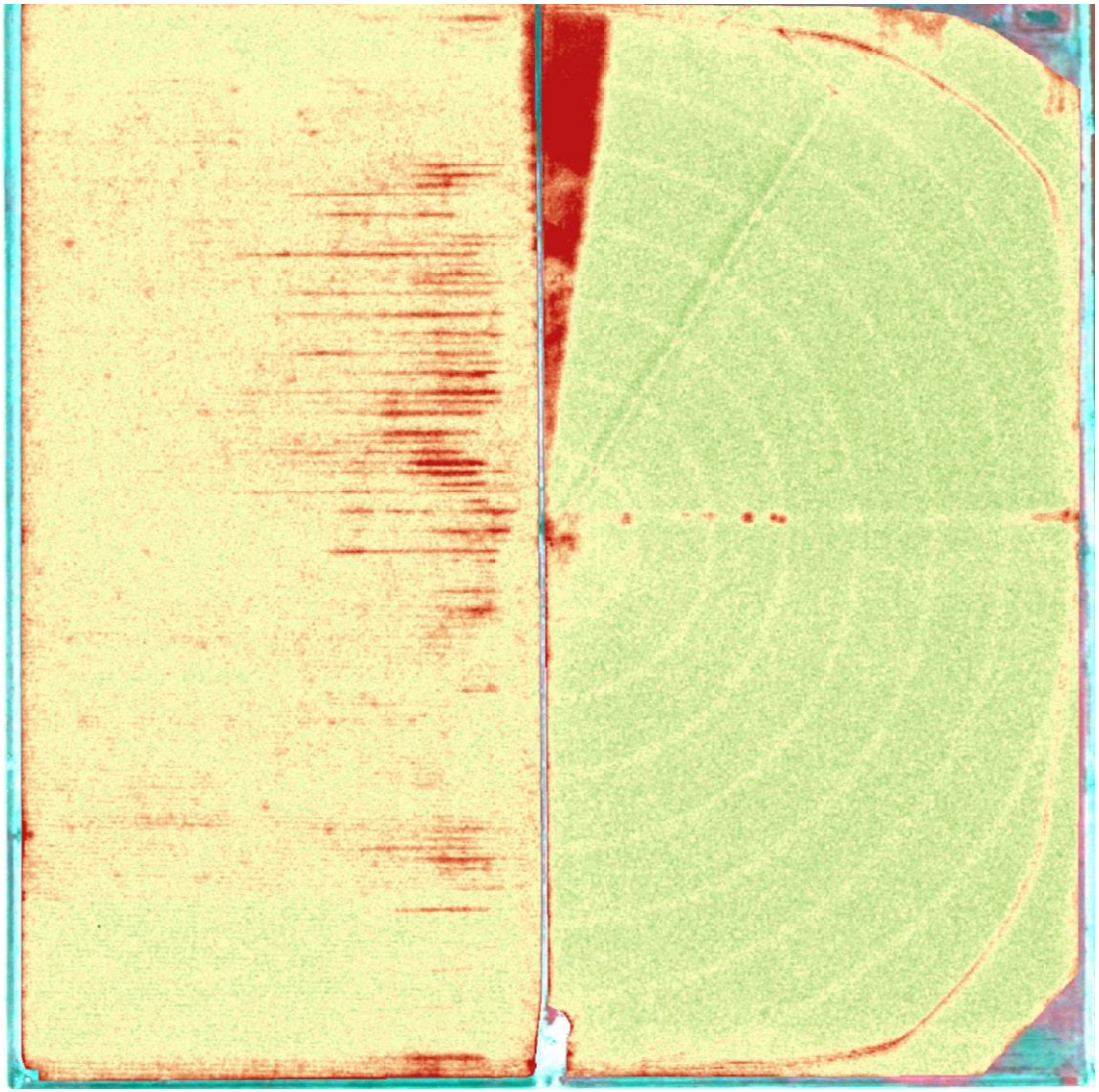
N Rate

very low *medium* *high*

cut-back


NDVI map
Row Direction ?
Tell-Tale - - - - - - -
Cultural Practices ?

Irrigated Corn - 2012



Furrow

Pivot

Color IR Image

NDVI Map

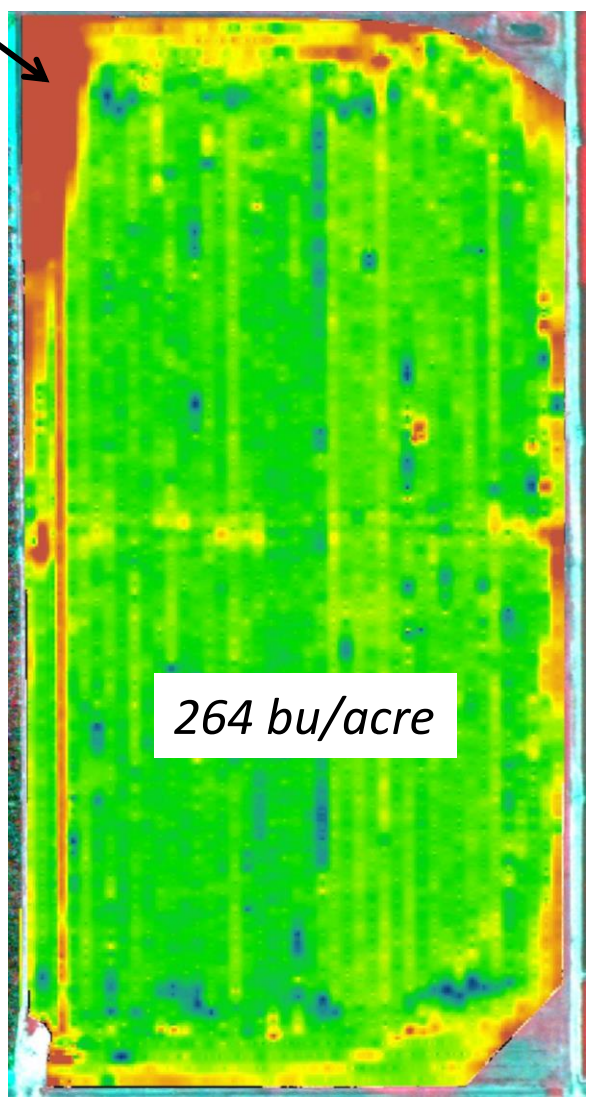
Grain-fill (R2)

Best

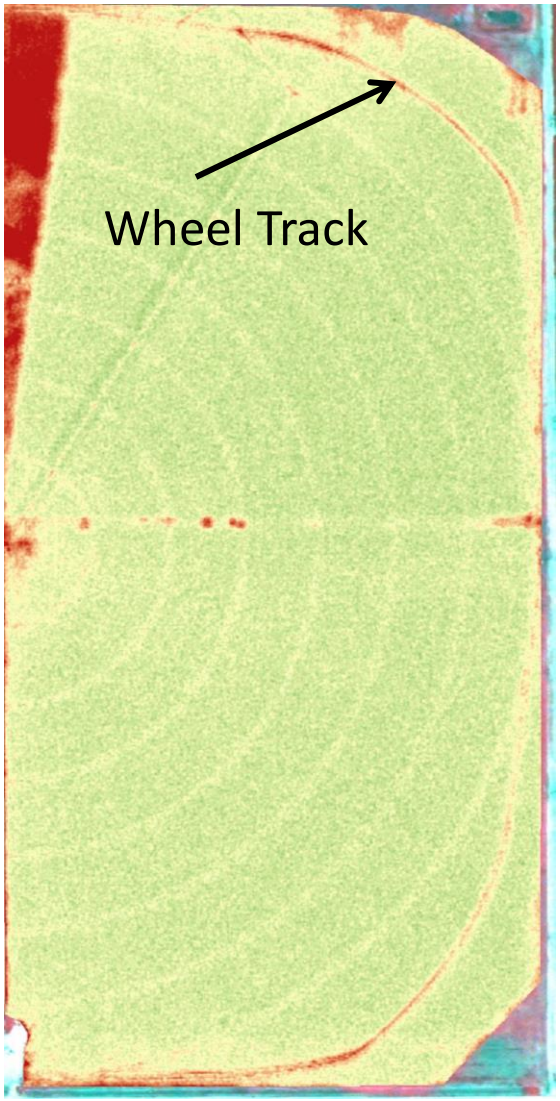
Average

Worst

Irrigated Corn - 2012



Yield Map



NDVI Map

Color IR Image

NDVI Map

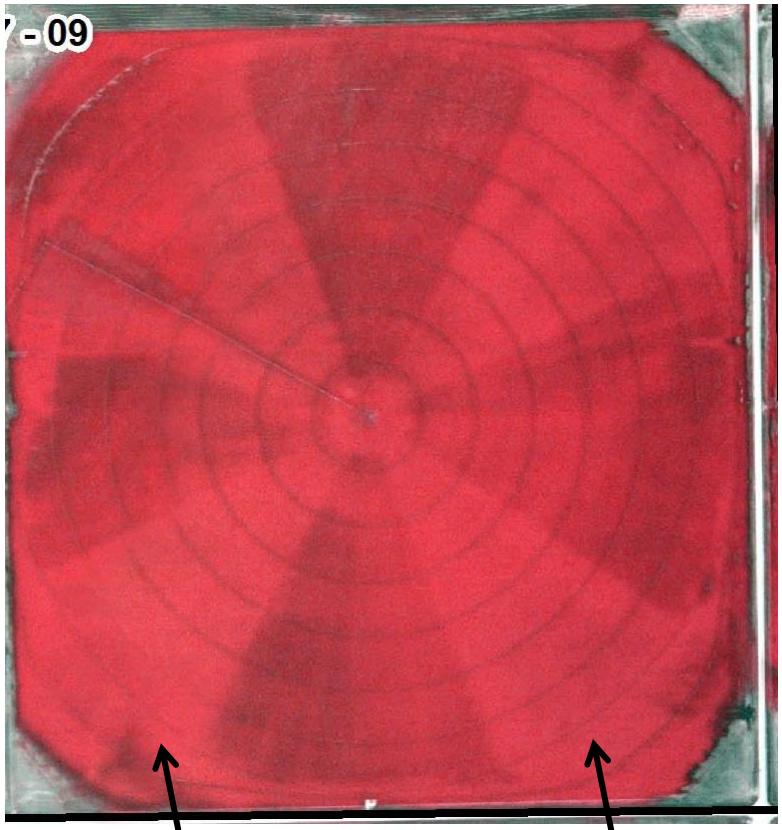
Grain-fill (R2)

Best

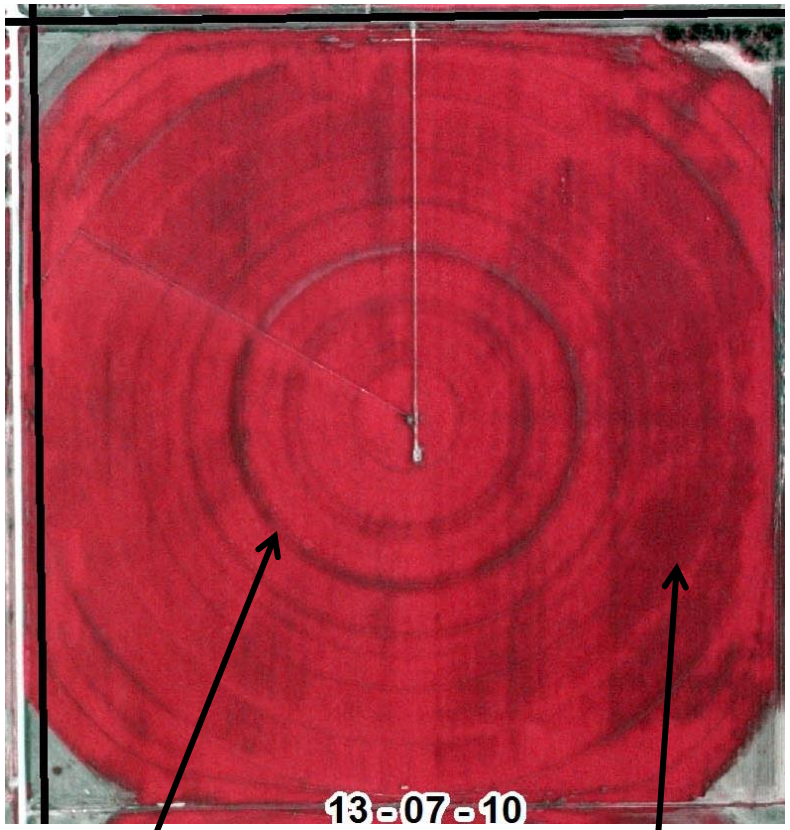
Average

Worst

Color IR Image (Corn 2012)



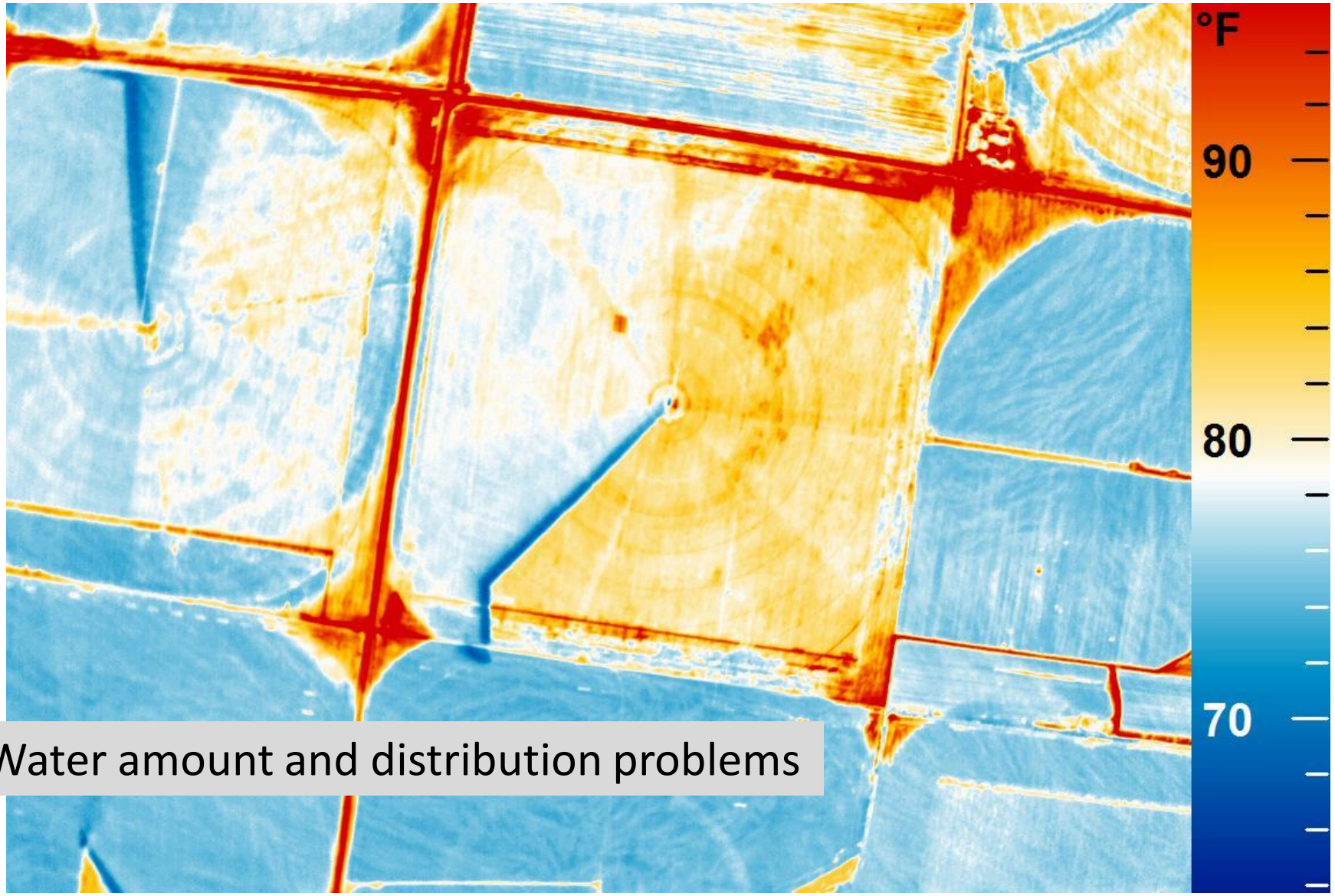
Low water application rate in corners when swing-span is extended



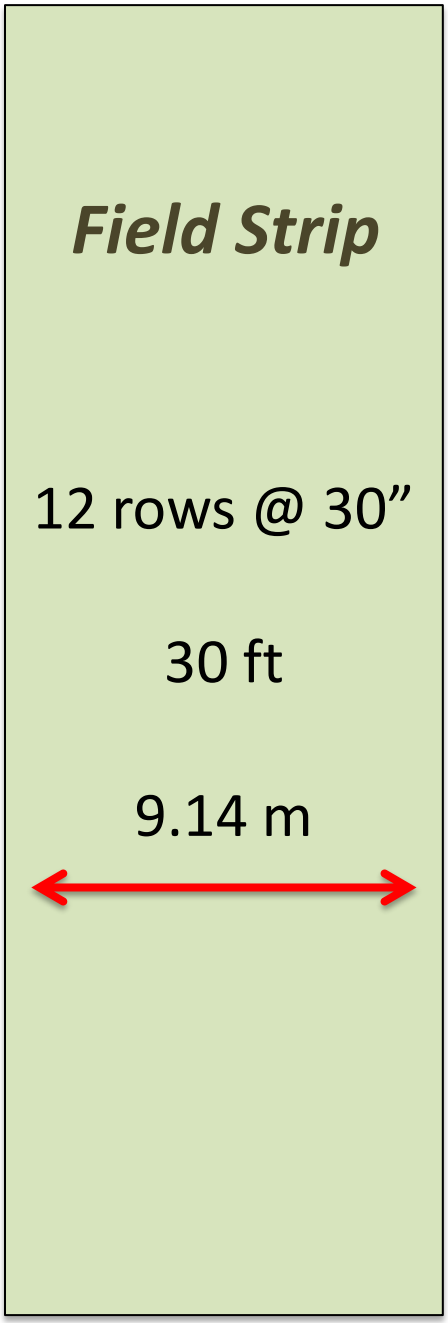
Nozzle problem near pivot track

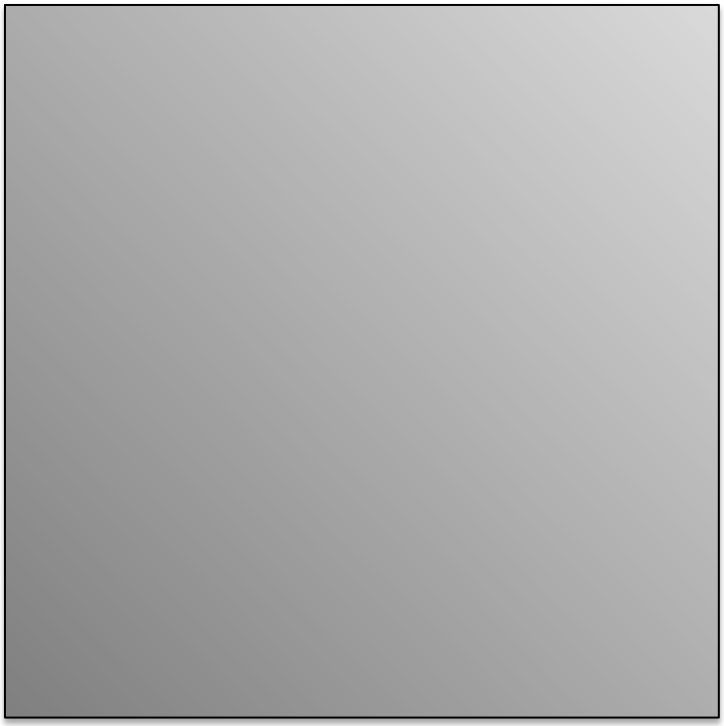
Cultural practice difference (hybrid, previous crop, ?)

Thermal Infrared *(canopy temperature)*



Water amount and distribution problems

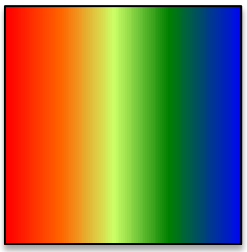




15 meter

LANDSAT 8

“free”



5 meter

2 meter

1 meter

Spatial Resolution

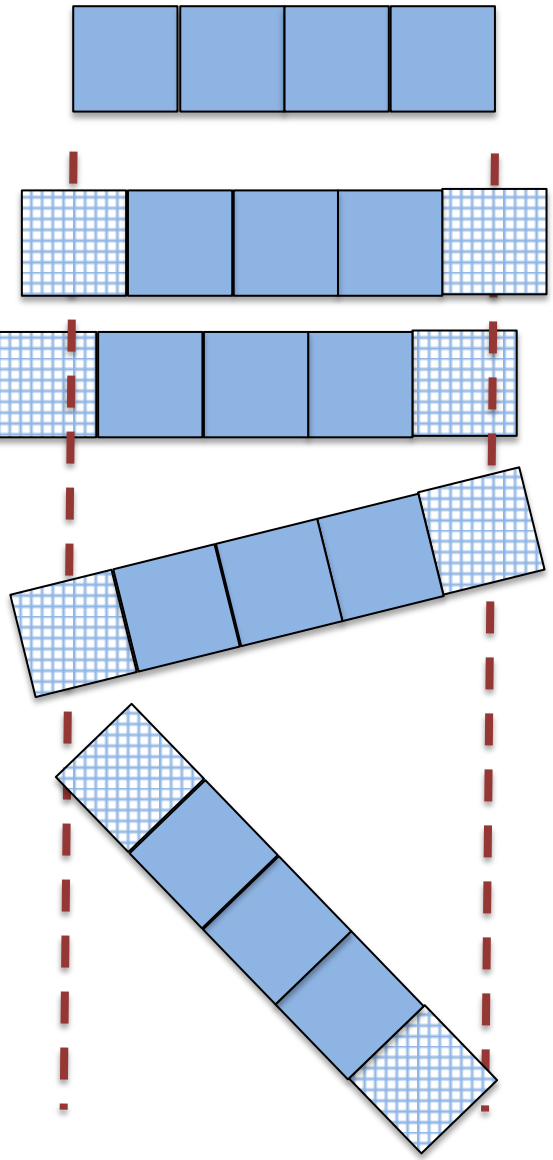
Rule of Thumb

Need 4 to 5 pixels (cells) within the width of the target being managed

by the

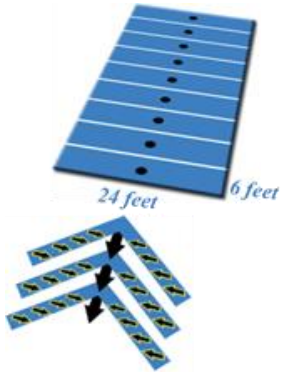
- Row
- Combine width
- Planter width
- Sprayer width

Mixed Pixel



Problems with Spatial Resolution

- Yield maps



Width of combine head (6 – 12 rows, 15 – 30 ft)
Ground speed (~4 mph)
Recording frequency (1 or 2 Hz)
Grain-flow delay off-set (~12 sec)
Wedge-shaped cell
~250 cells/ac (12 rows @ 4 mph and 1 Hz logging)
~125 cells/ac (12 rows @ 4 mph and 2 Hz logging)

- Imagery

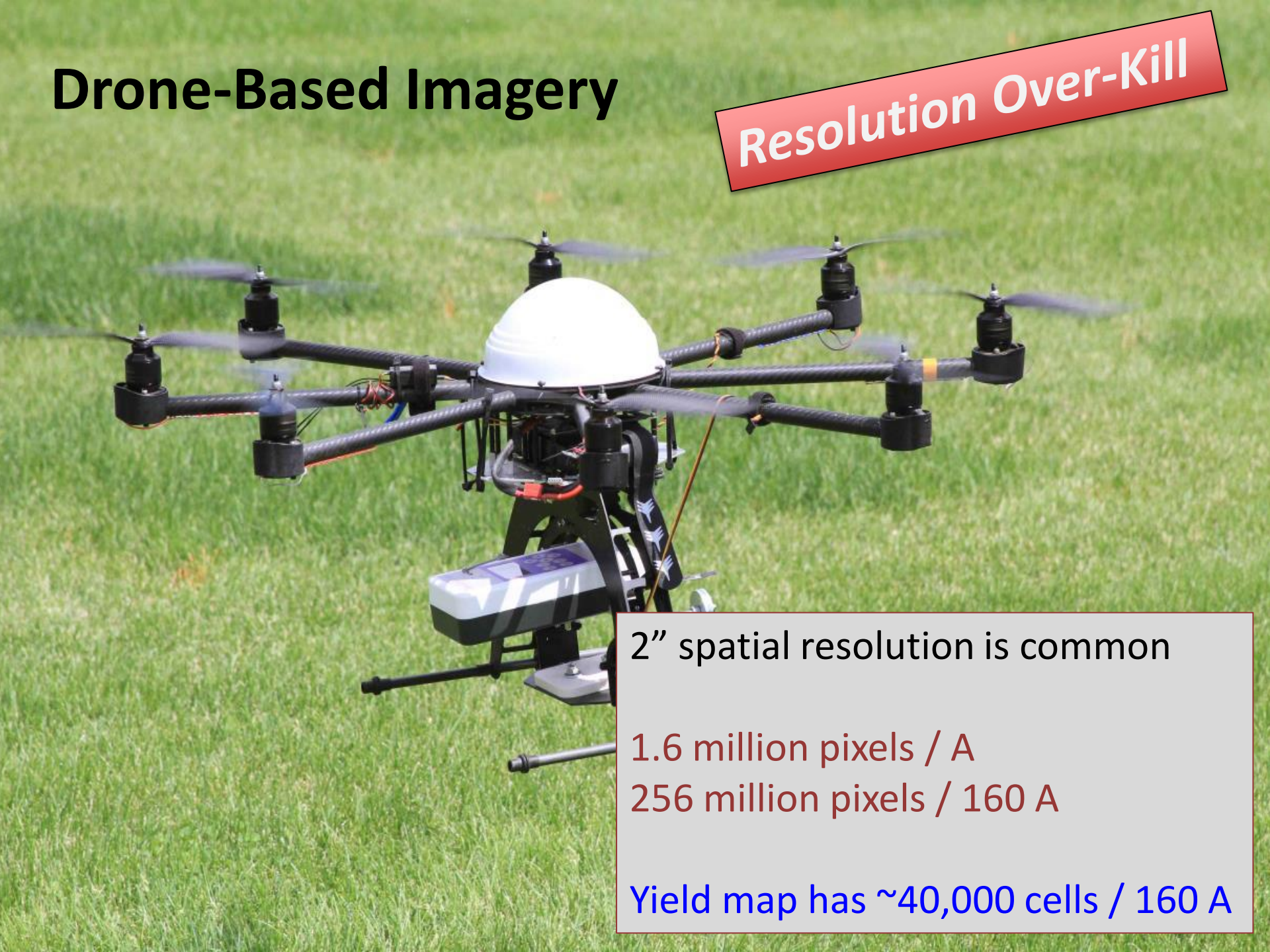
Inches to many feet
~1.6 million pixels/ac @ 2 in
43,560 pixels/ac @ 1 ft
10,890 pixels/ac @ 2 ft
4,840 pixels/ac @ 3 ft
1,210 pixels/ac @ 6 ft
194 pixels/ac @ 15 ft

Cell and pixel shapes are different

Re-sampling

Drone-Based Imagery

Resolution Over-Kill



2” spatial resolution is common

1.6 million pixels / A
256 million pixels / 160 A

Yield map has ~40,000 cells / 160 A

Drone Update

- FAA rules apply to all drone operations
- All drones must be registered ($5)
- Height <400 ft
- Must remain within eye sight
- Three user categories

Hobby

Civil - any kind of commerce activity or when decisions are made based on the imagery or data ***(requires pilots license, 333 exemption, and observer)***

Government - police, fire departments, etc

Recent entry in drone use by ***John Deere***

Sentera Becomes John Deere Operations Center Production Partner

February 2, 2016, MINNEAPOLIS, Minn. — Sentera LLC, a global provider of software, sensors, and drone technologies to the agricultural industry, announced completing the integration as a John Deere Operations Center Production Partner.

- ***AgVault Software and Mobile App:*** Allows farmers to view crop health imagery and historical data at the field edge and quickly transfer prescriptive analytics into farm equipment

- ***Single and Double Sensors:*** precision scouting tool using ***high-resolution RGB***, near-infrared (***NIR***) and normalized difference vegetation index (***NDVI***) data

- ***Drones:*** Includes the DJI Phantom 3 quad-copter and Sentera Phoenix 2 fixed-wing drone.

Sentera's products will be available for the 2016 planting season.

See: http://www.precisionfarmingdealer.com/articles/1973-sentera-becomes-john-deere-operations-center-production-partner#sthash.zERj7YsM.dpuf

John Deere Announces New Software for Operations Center

February 4, 2016, OLATHE, Kan. — The John Deere Operations Center is a set of online tools that enable growers to easily access farm information for better management of their operations.

The new tools and features available in the Operations Center include:

- ***Prescription Creator by Agrian*** —easily make management zones and variable rate prescriptions for seeding and application operations.

- ***4600 CommandCenter doc data compatibility*** — agronomic data captured and stored and viewed in Operations Center.

- ***SeedStar Mobile integration with Job Monitor*** — remotely monitor planter

- ***Data cleanup tools*** — adjust documentation data, such as crop type, variety and crop season.

- ***Setup Builder enhancements*** — generate templates and profiles.

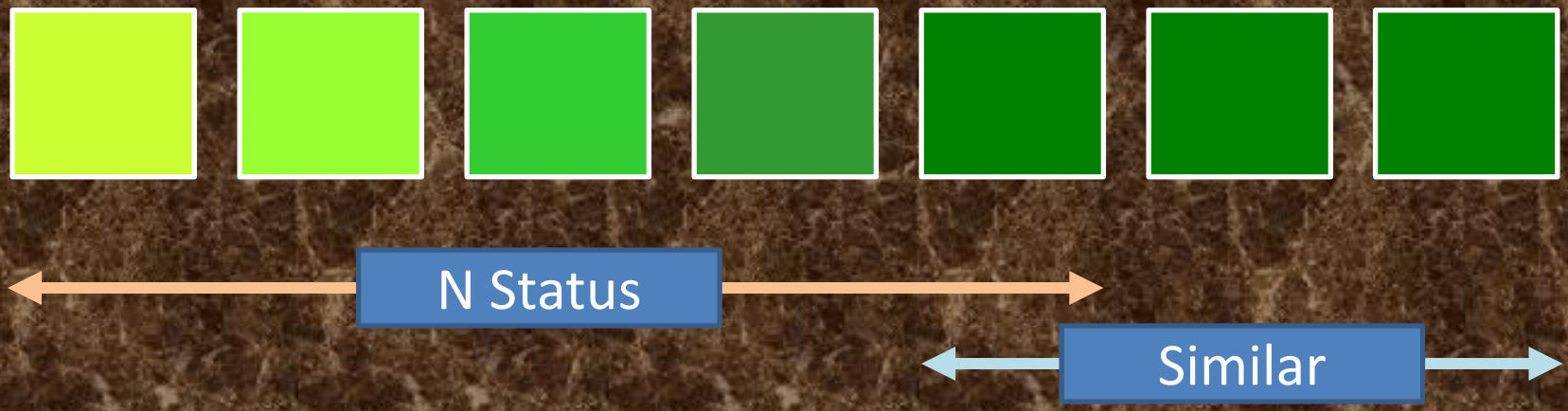
- ***Shapefile export of application data*** — export application data

See: http://www.precisionfarmingdealer.com/articles/1980-john-deere-announces-new-software-for-operations-center#sthash.TOl5fHlz.dpuf

Remember - - - -

Canopy sensors and imagery respond to :
"living biomass" and ***"chlorophyll content"***

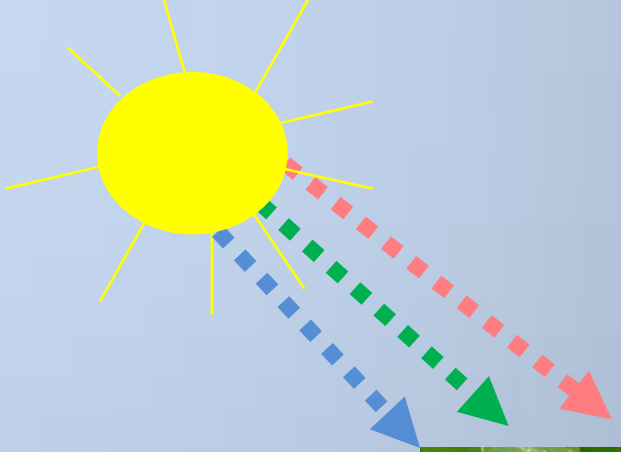
Treatments / N-rates



Sensors and images can not quantify excess N

AND

Soil background reduces sensitivity



Photosynthesis

Chlorophyll

Biomass

Assumes nutrients and water are adequate

Productivity (yield) is proportional to :

Chlorophyll Content **X** ***Incoming Radiation***

Previous Crop

Programs that consider the previous crop in terms of legume credits also credit for manure and other non-fertilizer sources of nutrients.

Residual N

Preplant soil sampling (mostly field level, but some spatial)

- Conventional extraction with wet chemistry analysis
- Ion exchange extraction with wet chemistry analysis

In-season soil sampling for side-dress N recommendation

- Conventional extraction with wet chemistry analysis
- Rapid “in-field” procedure for extraction of nitrate in moist soil with ***nitrate electrode*** analysis

Field vs. Spatial Recommendations

Spatial recommendations for plant population and variable rate fertilizer recommendations are provided if requested

Cultural Practices

Generally not emphasized but considered by some services

In-Season Advice

Some nearly exclusively, others limited

Marketing
(sales & purchases)

Some through Agronomists and Consultants

Multiple Product Sales

Usually not a part of the service, but some offer tailored products

Web Sites

Summary

Pioneer – support services, profitability, stability, sustainability

SSURGO soil data base; long-term and real-time climate; LIDAR topography; model crop growth and water percolation; regional yield data; residual N; spatial N recommendations: (no remote sensing or tissue testing)

Climate Corp – maximize inputs while optimizing yield

SSURGO soil data base; long-term and real-time climate; model residual N, crop growth and hydrology; field-level N recommendations: (no remote sensing or tissue testing)

Adapt-N – maximize profits, risk mitigation, environmental benefits

SSURGO soil data base; organic matter; long-term and real-time climate; in-season residual N; model mineralization, N losses, crop growth and water processes; field, zone or spatial N recommendations: (no remote sensing or tissue testing)

WinField – maximize yield profitability

real-time climate and future predictions; model precipitation, N inputs, N losses, and yield potential; spatial N recommendations; ***Answer Plots***; satellite imagery; tissue testing:

Summary

Western Ag – optimize profitability using root interaction functions for N, P, K, & S, fertilizer prices and crop prices

Effective and long-term precipitation; heat units and ET; soil texture, compaction, pH, and EC; residual N and 24-hr mineralization; import yield maps and imagery; field or spatial recommendations: (no tissue testing)

Farmers Edge – sustainable production of high yield and high quality crops

Real-time farm-specific meteorology; management zone soil data; integrate crop and soil processes; field-level recommendations: (no remote sensing or tissue testing)

ServiTech – optimize producer profitability (recommends appropriate technologies)

On-line and commercial weather; zone or grid soil sampling; weekly soil cores for water management; field and spatial recommendations; weekly scouting: (no remote sensing or tissue testing)

Summary

Beck's Hybrid – increase profitability using web-based program to monitor variables and analyze data

SSURGO soil types; Davis weather stations for real-time weather; 4-band NDVI imagery; management zone recommendations; yield map analysis: (no tissue testing)

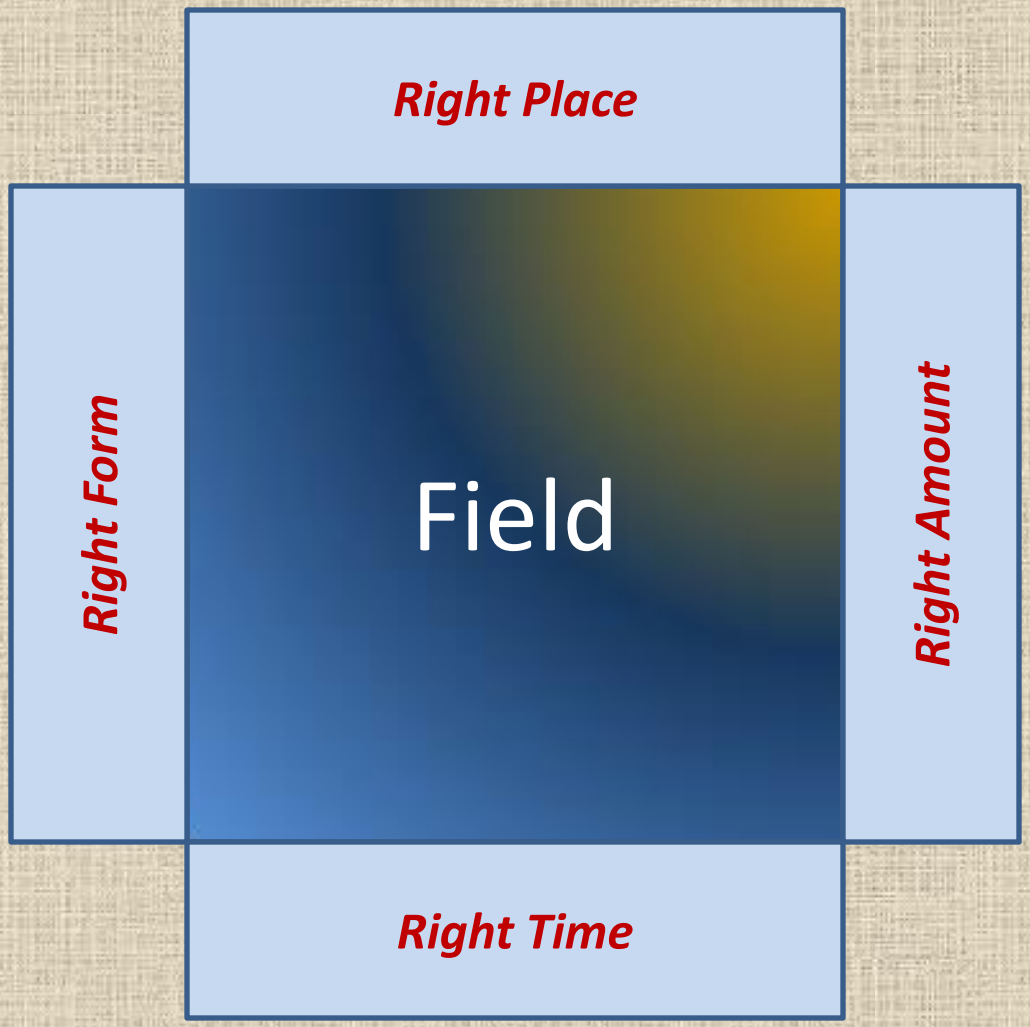
Yield 360 Center – measure and supply the right amount of N when the crop is ready to use it

Anhydrous ammonia metering system; pre-plant base N with in-season rapid nitrate test; Y-Drop liquid N nozzle system; field or spatial N recommendations: (no remote sensing or tissue testing)

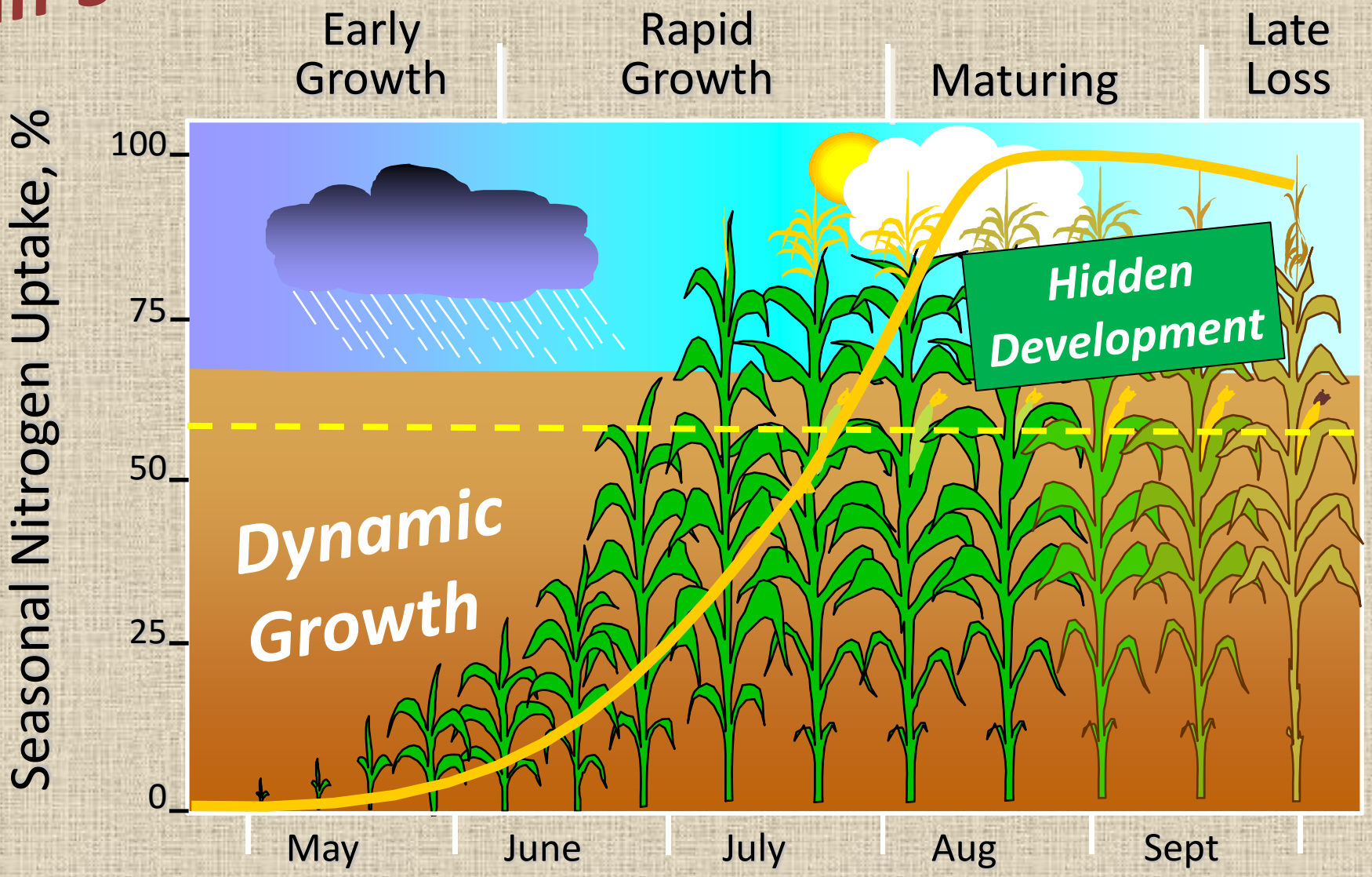
SatShots – deliver imagery that facilitates spatial analysis and variable-rate applications in fields

Provide access to current and historic satellite and aircraft imagery from various sources having different spatial resolutions and spectral characteristics, including analysis as requested: (no tissue testing)

4Rs



In-Season Analysis




Low Hanging Fruit in 2016
Nitrogen is relatively inexpensive compared to other nutrients
Is it safe to skimp on other nutrients ?
Expect promotion of "Miracle" products
Promoted As
Enhancers
Promoters
Protectors
Stimulants
$ $ $ $

Mathematics can be Interesting,
but Common-Sense is Powerful

Four brothers were traveling to a field day. One of the brothers owned the car and was driving. The car developed a problem and had to be repaired. The brothers had agreed to split the repair expenses four ways. After the repairs, one brother asked the driver how much the others owed. The total bill was $28 (the math follows).

4 cannot be divided into 2, but it can be divided into 8 with a quotient of 2 and remainder of 20.

4 can be divided into 20 with a quotient of 5 and remainder of 0

The driver said that each brother owed him **$25**.

```
   2 5
  ____
4 | 28
    8
   --
   20
   20
   --
    0
```

One of the older brothers told the youngest brother to check the mathematics because he had graduated from high school. The young brother wrote down 25 four times.

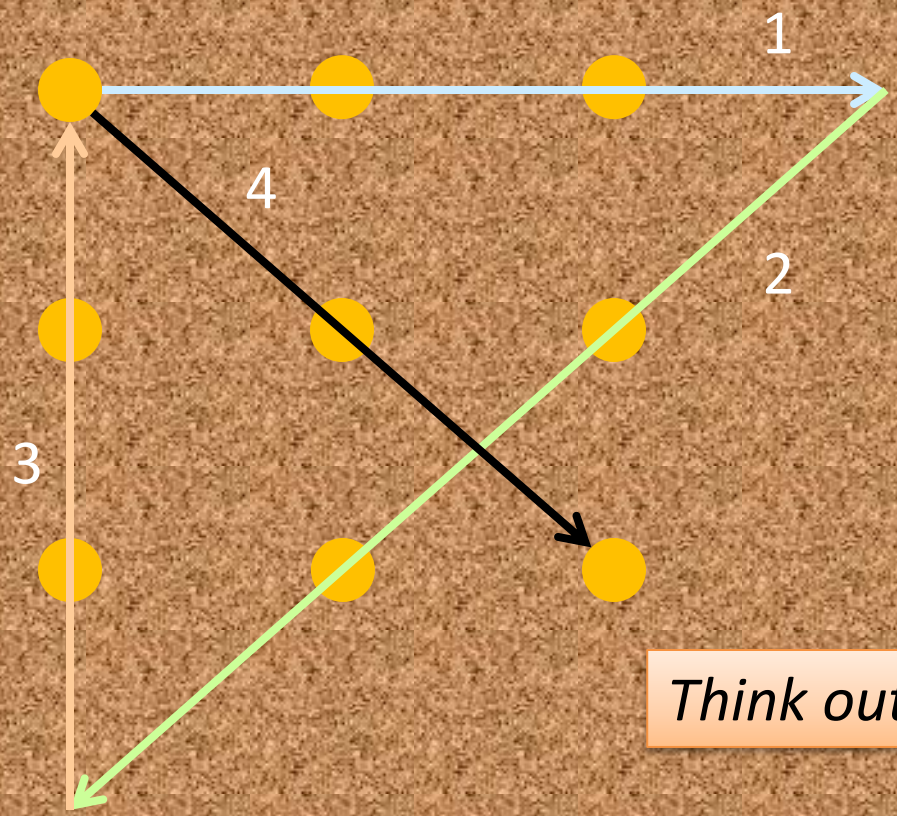
```
 2 5
 2 5
 2 5
 2 5
 ---
 2 8
```

He counts down the right row (5, 10, 15, 20) and then went to the top of the left column and continues counting (22, 24, 26, 28).

He announces that each brother owes the driver $25.

Precision Agriculture is about ***innovation*** and ***thinking outside the box***

How would you connect these nine points with ***four continuous lines*** ?



Think outside the box !

Thank You

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