

# KANSAS WATER OFFICE

## WATER INNOVATION SYSTEMS AND EDUCATION



# W.I.S.E. Program

## (Water Innovation Systems and Education)

Existing water technology efforts have grown into a new comprehensive Water Innovation Systems and Education (WISE) initiative. The program is a public/private partnership program that focuses on fostering the implementation of field practices, technology and management strategies for industrial, agricultural and municipal water applications; with the goal resulting in measurable and scalable ground water conservation, improved water quality and overall soil and ecological health. The program is an expansion of our legacy Water Technology Farm and PACE Farm programs, and includes the development of a state-wide Master Irrigator and innovative farm cost-share program. Transition to the Partnerships funding line would provide additional state resources to leverage federal, local, and private resources, alike, from across Kansas with a priority on conserving and expending the Ogallala-High Plains Aquifer.



# W.I.S.E. Program

## Overview

### Water Innovation Systems and Education (W.I.S.E.) Farms (2022-2023)

- Water Technology Farms (legacy 2017-2022)
- P.A.C.E. Farms
- WISE Farms
- WISE Tours
- Field Days
- Product/Service Demos
- Producer Training
- Stakeholder Round-table Meetings
- Master Irrigator
- Workforce Development
- Higher Education
- Agency/Organization Coordination
- Agency/Organization Training
- State-wide Advisory Board
- Innovation Cost-share Program



# W.I.S.E. Program

## Philosophy

- Multiple (even uncommon) systems working together as one toward a common goal! *Perhaps its technology, soil health and field practices working together, or perhaps its community, policy and education, etc.*
- Three cycles of progress for everyone! *If everyone starts from where they are and makes progress forward “three revolutions”, we will see measurable success from our common efforts – exponentially!*
- Today! *While we still have our resources, options, and time – lets get this done!*





# W.I.S.E. Program

## Lessons Learned

### Lessons Learned from legacy Water Technology Farms

- Finding out what's REALLY working
- Getting producers to the fields
- Getting the results into the hands of producers
- Getting producers to implement new practices and equipment
- Scaling cost-share for irrigation innovation practices and equipment
- Training producers on new practices and equipment
- Accessibility to service providers and equipment
- Producer needs vs. industry availability and capability



# W.I.S.E. Program

## Adoption Pathway



1. Driving Factors
2. Field Practices Analysis
3. Soil Health Analysis
4. Irrigation Equipment Performance
5. Education and Training (Master Irrigator)
6. Precision Practices Adoption
7. Advanced Irrigation Management Practices
8. Advanced Cropping/Grazing Practices
9. New Markets and Deliverables
10. Personal Development, Accountability and Leadership



# W.I.S.E. Program

## Phase 1 – Driving Factors

AM I READY TO IRRIGATE THIS FIELD?



Just pump the water and irrigate - right?



# W.I.S.E. Program

## Phase 1 – Driving Factors



- WHAT'S THE HISTORY OF THIS FIELD?
- IS THIS THE RIGHT CROP TO BE GROWING IN THIS FIELD?
- HOW MUCH WATER DO I NEED TO USE FOR THIS APPLICATION - SPECIFICALLY?
- CAN I REALISTICALLY MEET THE LONG-TERM NEEDS OF THIS CROP SYSTEM YEAR-TO-YEAR?
- HOW CAN I GET MORE RETURN FOR EACH GALLON OF WATER USED?
- IS MY GOAL TO MAKE A CONSISTENT PROFIT OR JUST GAIN THE HIGHEST YIELD?



# W.I.S.E. Program

## Phase 1 – Driving Factors

- HOW MUCH WATER IS ACTUALLY MAKING IT INTO THE CROP?
- WHAT ARE THE RANGES OF CLIMATE FACTORS I NEED TO BE PREPARED FOR?
- WHAT IS THE QUALITY OF THE WATER I'M USING?
- IS THERE ANYTHING I'M DOING THAT'S WORKING AGAINST ME?
- WHAT FACTORS CAN I CONTROL?



# W.I.S.E. Program

## Phase 1 – Driving Factors

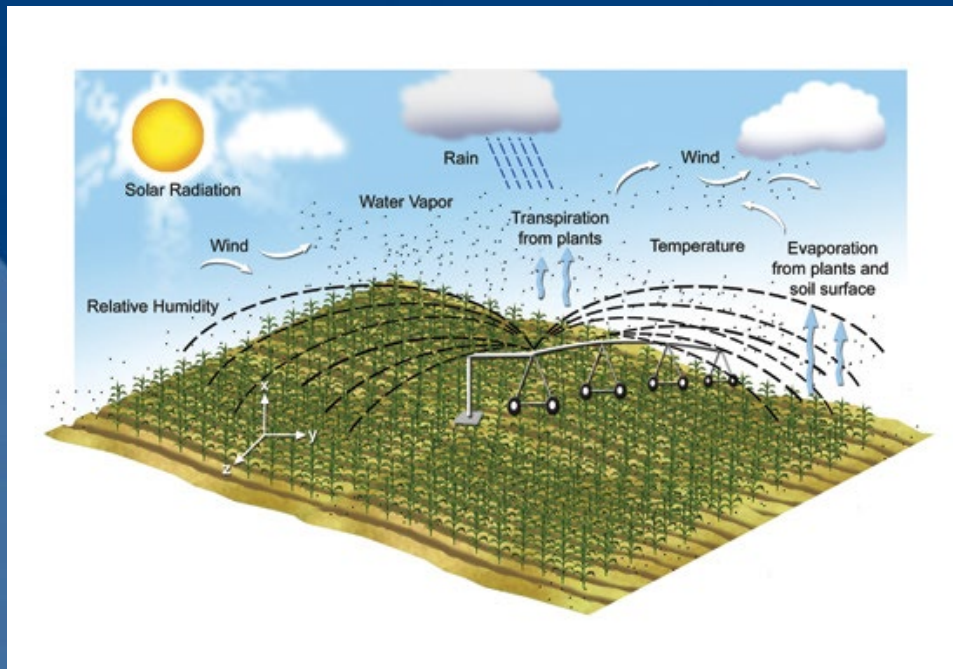
- WHAT'S GOING ON WITH THE GROUND-WATER UNDER MY FIELD?
- HOW MUCH AM I ACTUALLY CAPABLE OF PUMPING?
- HOW MUCH AM I ALLOWED TO PUMP?
- DO I NEED TO USE ALL THE WATER I HAVE?
- COULD I BANK SOME WATER NOW AND USE IT LATER WHEN I REALLY NEED IT?
- DO I NEED BETTER EQUIPMENT, MORE EDUCATION OR A CHANGE OF ATTITUDE TO MAKE WATER WORK BETTER FOR ME?



# W.I.S.E. Program

## Phase 1 – Driving Factors

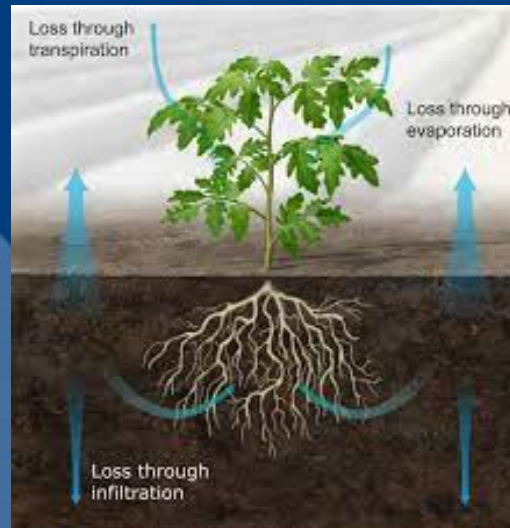
- HOW MUCH WATER CAN MY FIELD HOLD?
- HOW FAST CAN MY SOIL ABSORB WATER?
- HOW LONG WILL MY SOIL HOLD ON TO THE WATER I GIVE IT?
- HOW MUCH WATER AM I LOSING TO OTHER FACTORS?
- WHAT'S THE BEST COMBINATION OF FACTORS THAT WILL GET THE MOST WATER TO MY CROP ROOTS?
- CAN THE PLANT ACCESS THE WATER I'M GIVING IT?
- DOES IT REALLY MATTER WHAT THE NEIGHBORS THINK?
- HOW CAN I DO IT RIGHT EVERY TIME AND ON EVERY FIELD?





# Soil

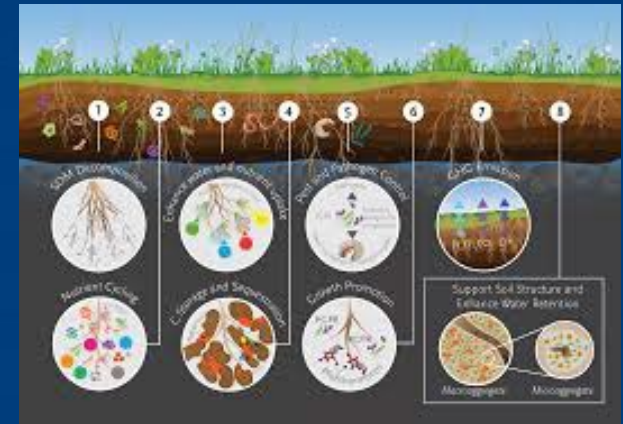
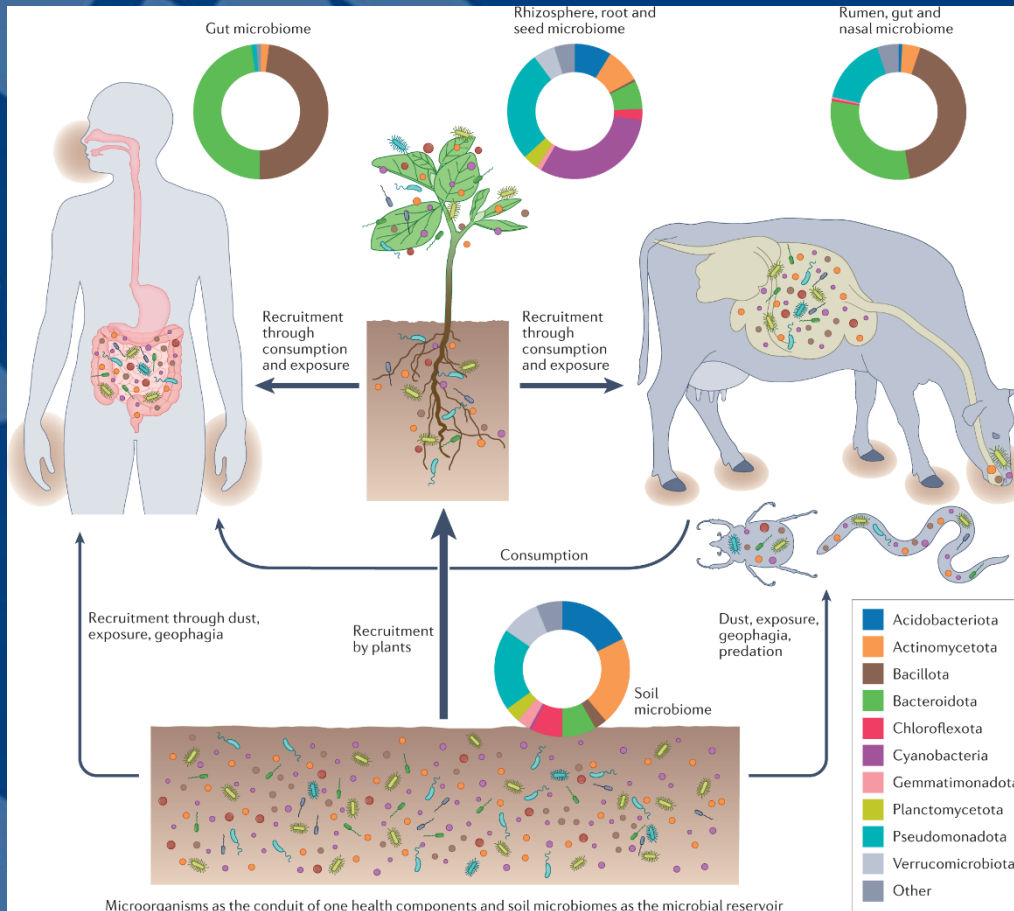
## Healthy Soil Systems





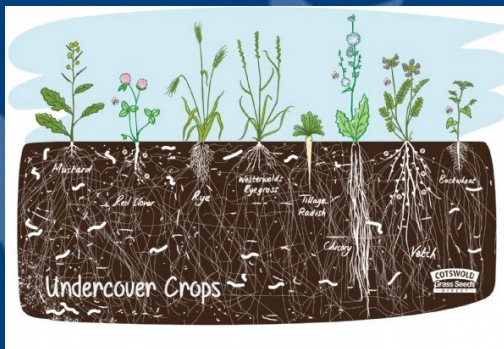
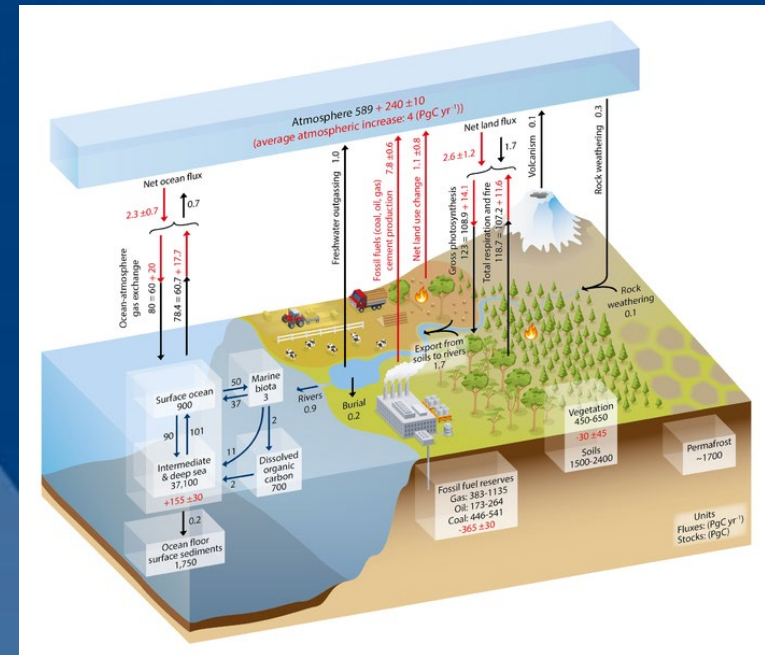
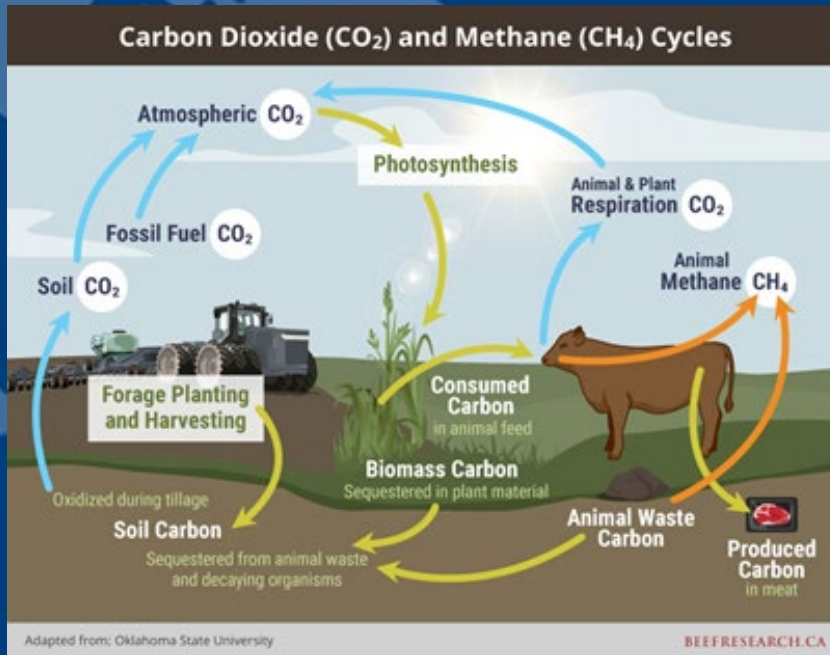
# Soil

## Soil Microbiome



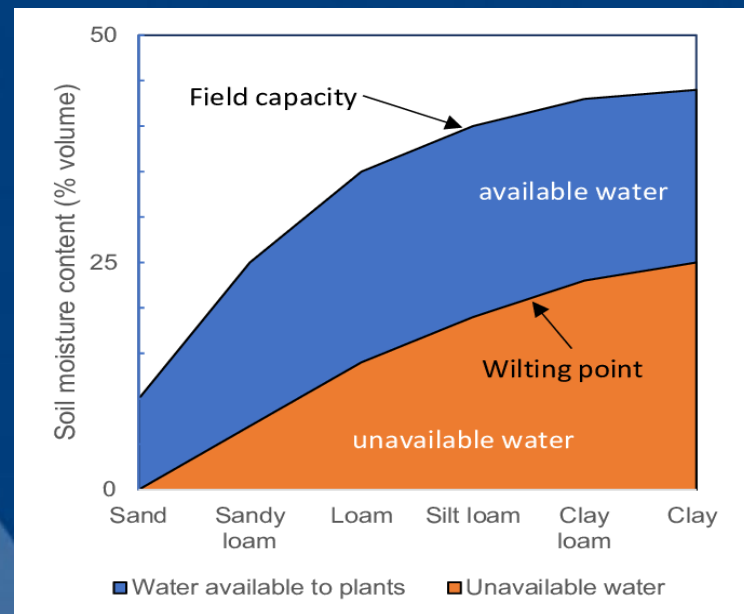
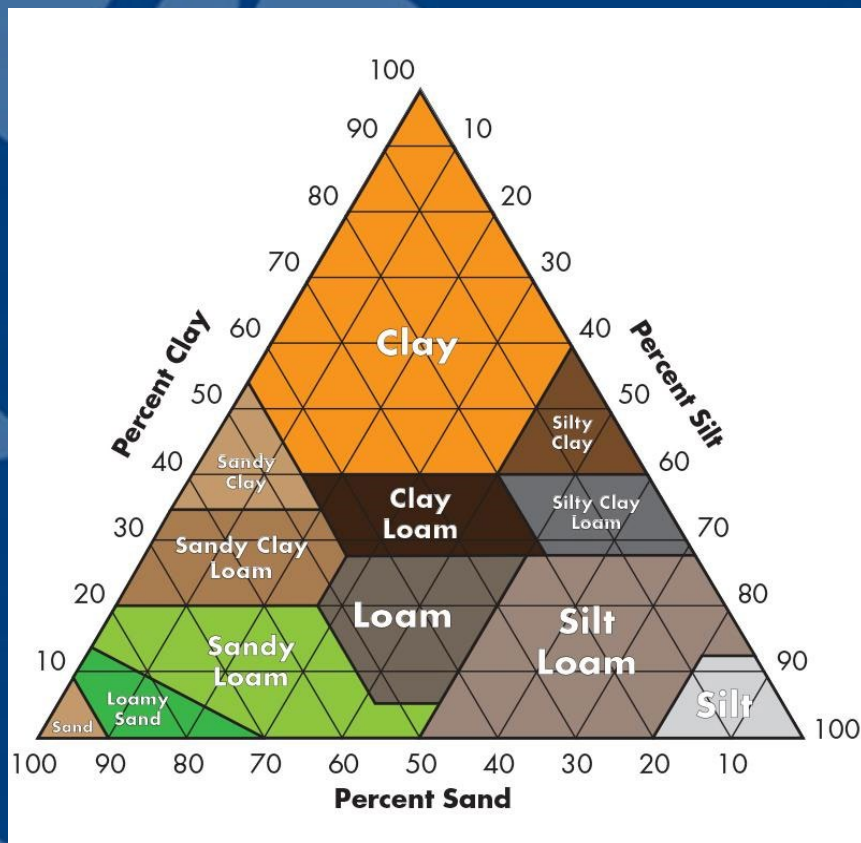
# Soil

## Carbon Sequestration



# Soil

## Soil Structure





# Soil

## Soil Water Relationships

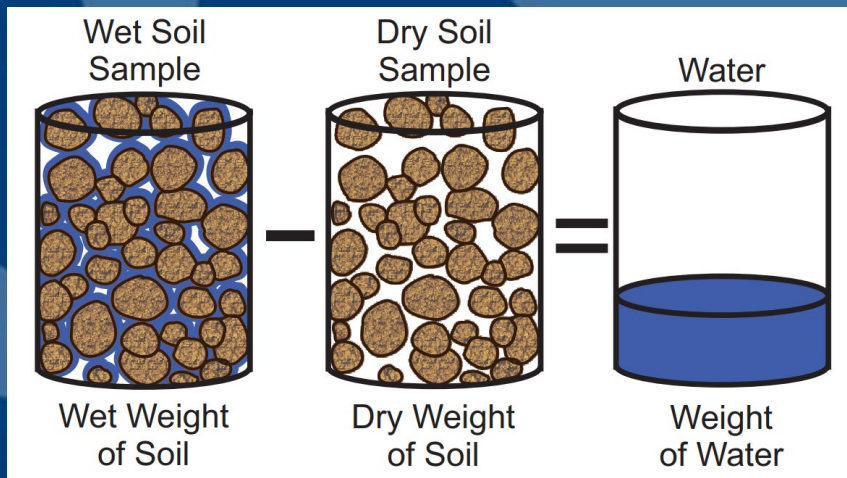
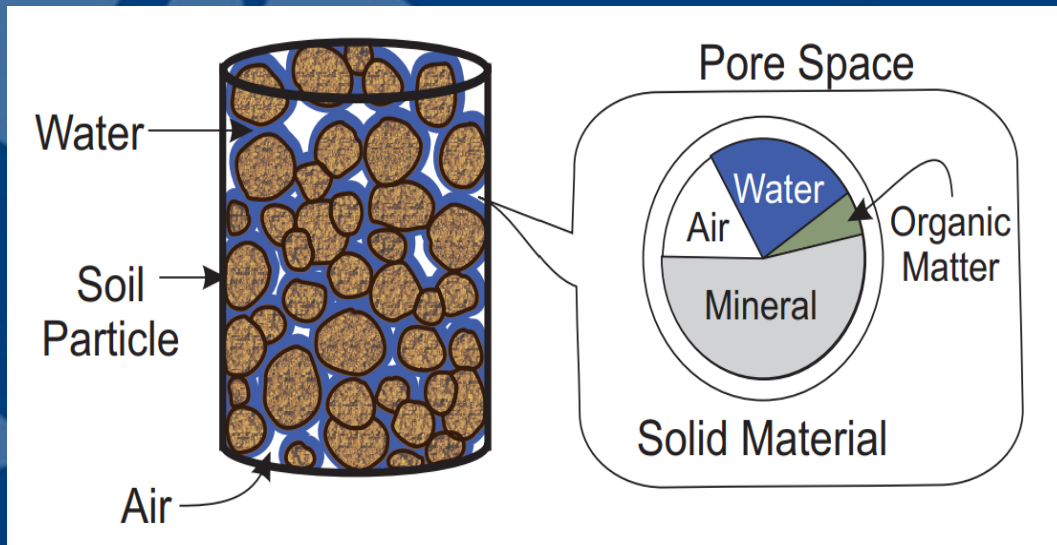


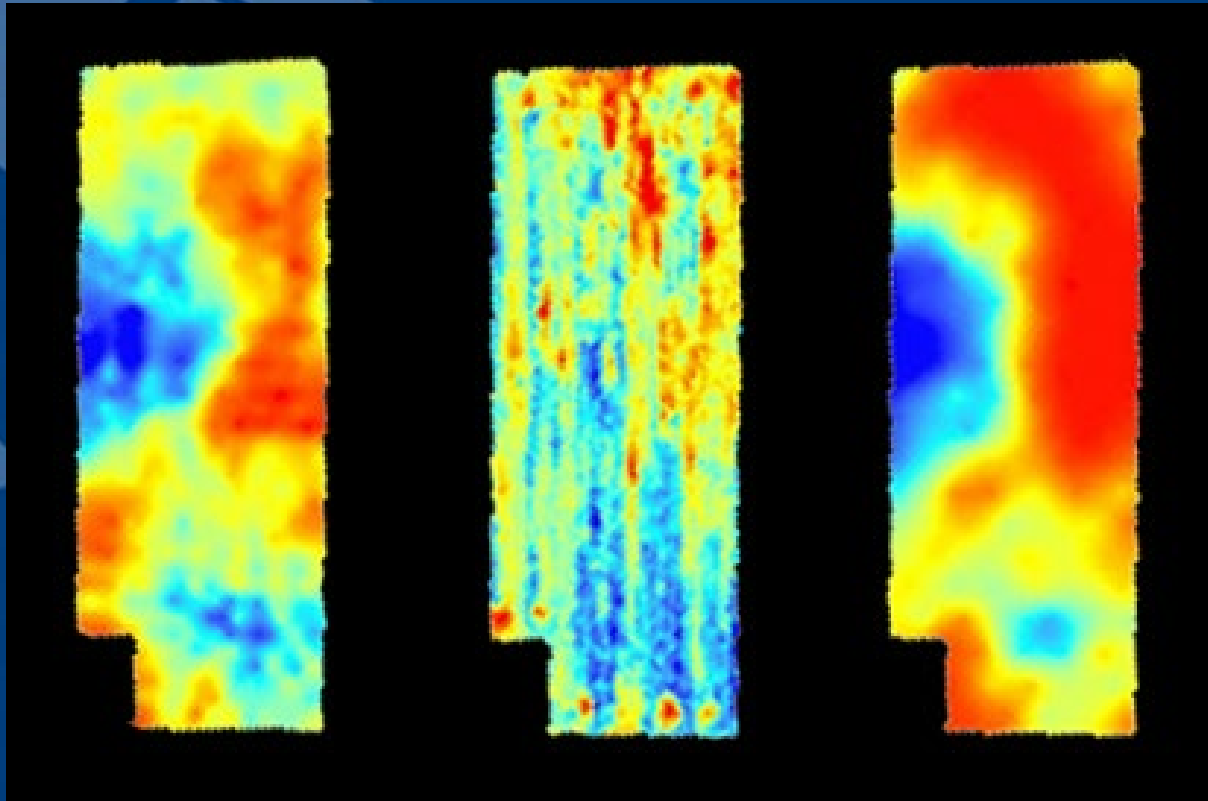
Image Sources: <https://extensionpublications.unl.edu/assets/pdfdoc2017.pdf>





# Soil

*"The Soil Doesn't Lie"*



EM Map

Yield

Soil Type

## Soil Sampling





# Soil

## Soil Analysis

### Cornell Assessment of Soil Health

- Available water capacity
- Aggregate stability
- Soil organic matter
- ACE protein index
- Respiration (4 day)
- Active carbon
- pH
- P
- K
- Minor elements

### Haney Soil Health Tool

- Water extractable C and N
- H3A extractable nutrients
- 24-hr burst test

### Productivity

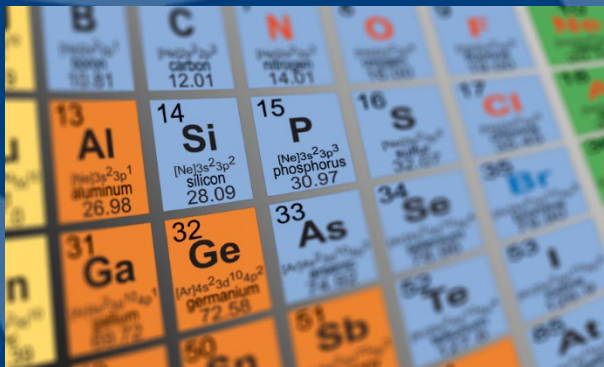
- Cash crop yield and quality
- Cover crop production and nutrient content

### Fertility Testing

- pH
- Electrical conductivity
- Soil organic matter
- P
- K
- S
- Cations
- Minor elements

### Additional Tests

- Microbial biomass C and N
- Phospholipid fatty acid profiles
- Nodule surveys on soybean
- Soybean Cyst Nematode (SCN)
- Earthworm survey
- Litterbags
- Aggregation



## Grid Soil Mapping



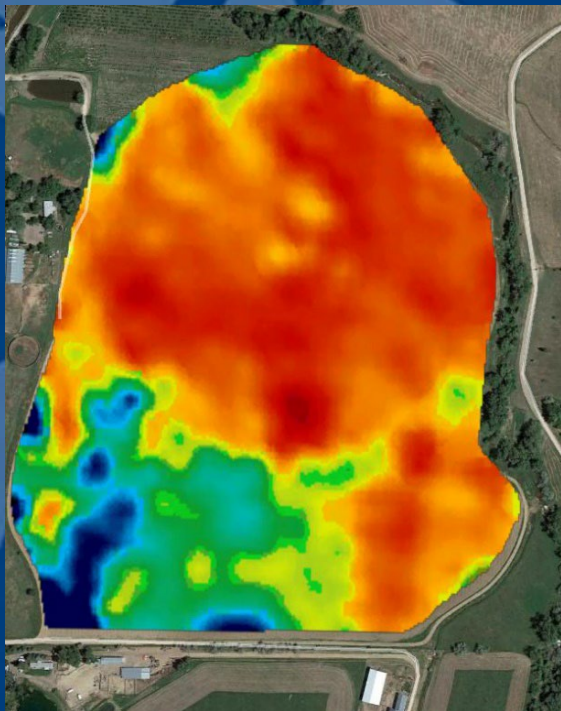


## Grid Soil Mapping



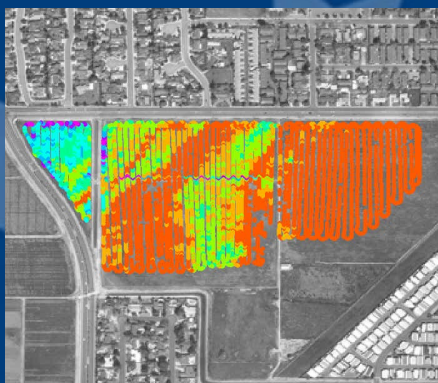
# Soil

## *Electro-Magnetic Soil Mapping*



Magnetic Fields determine changes in:

- Structure
- Texture
- Organic Matter
- Salinity
- Moisture Content



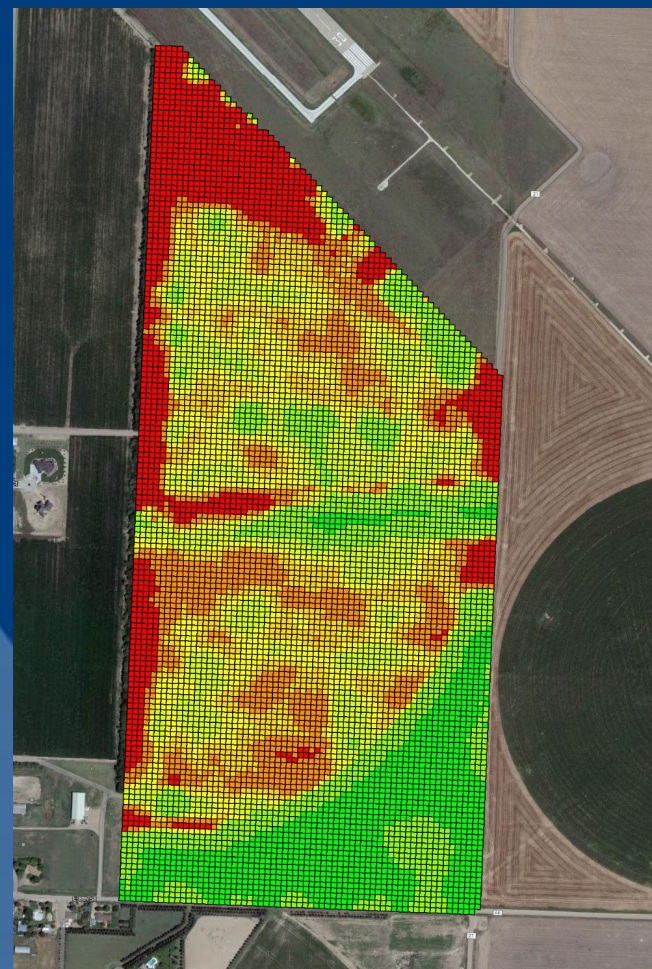
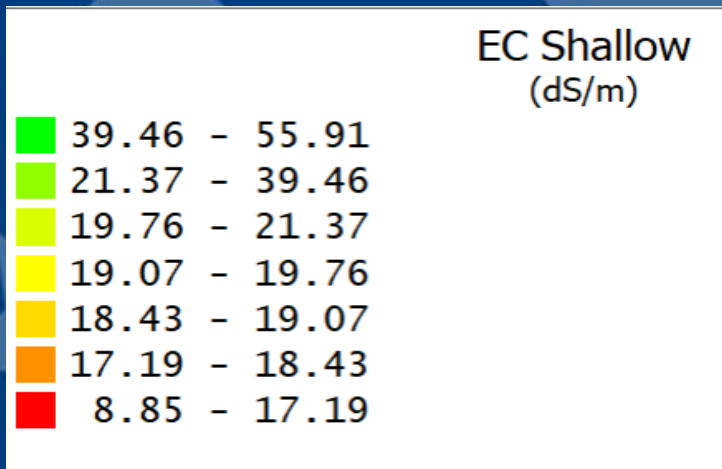


# Soil

## *Electro-Conductive Soil Mapping*

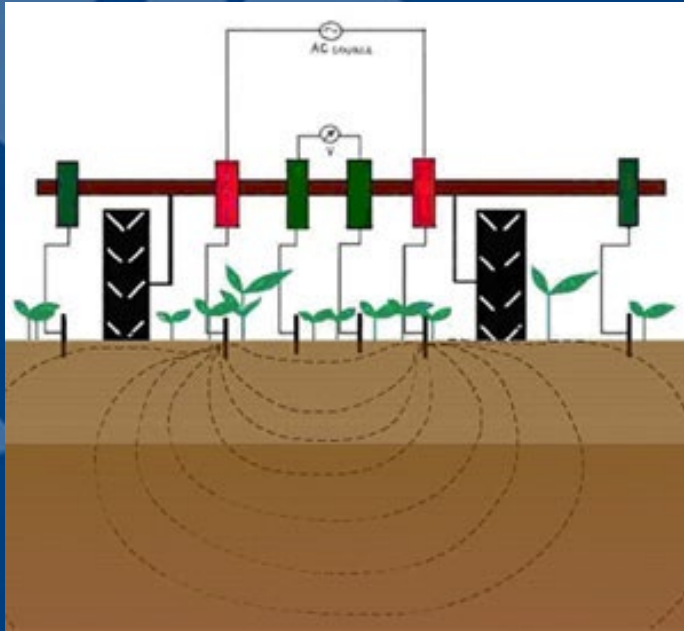
Electrical Conductivity determines changes in:

- Structure
- Texture
- Organic Matter
- Salinity
- Moisture Content
- pH



# Soil

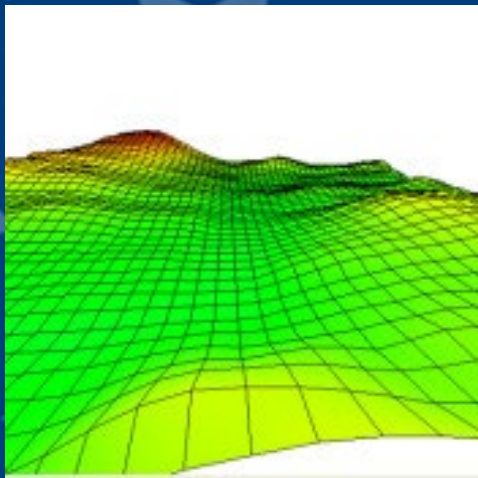
## *Electro-Conductive Soil Mapping*





# Soil

## *GNSS (RTK) Topographic Mapping*





# Crop Management

## *Crop Selection*



# Crop Management

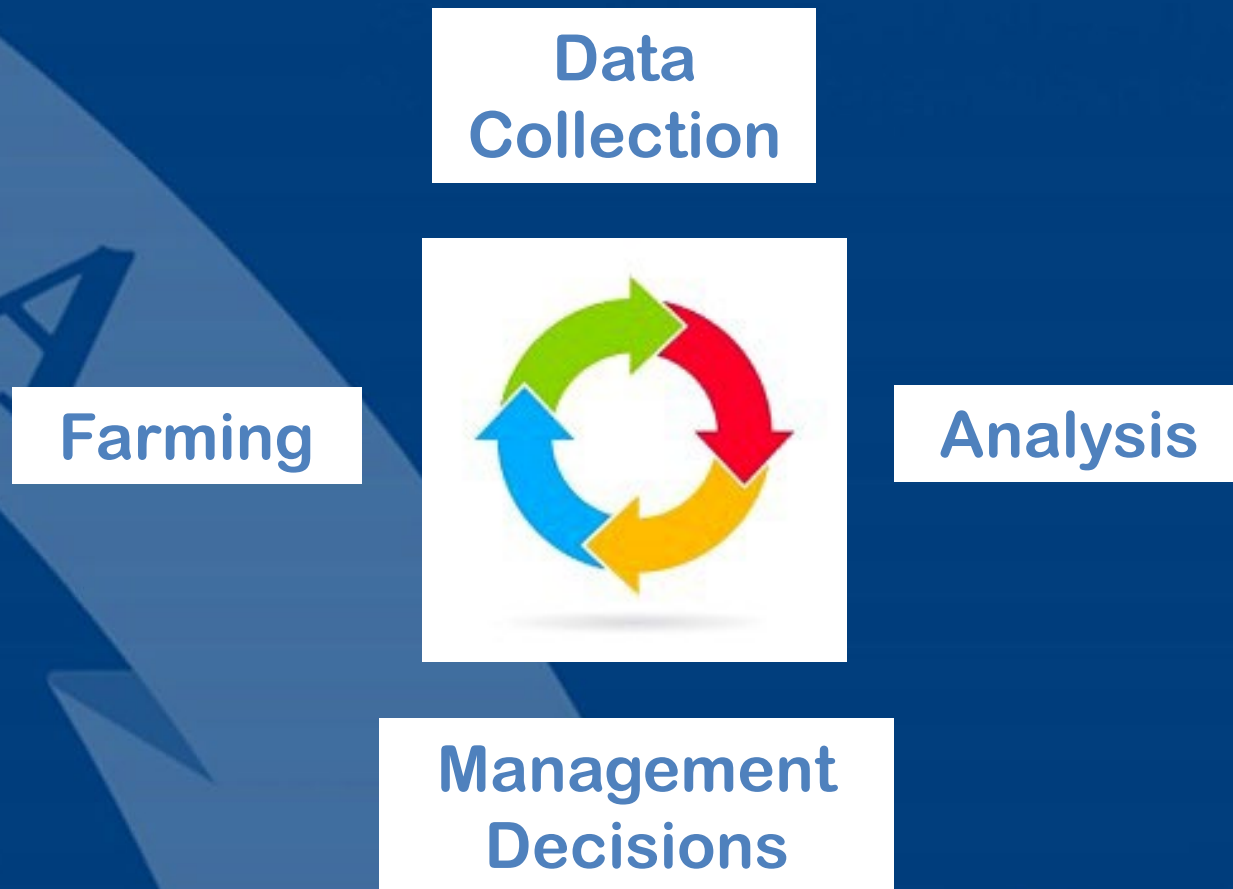
## *Varieties and Hybrids*





# Crop Management

## Precision Applications - Cycle



# Crop Management

## *Precision Applications - Cycle*

- Identify variables in each field that impact soil and plant health, demand unnecessary production resources, and reduce yield capabilities.
- Manage each crop production variable – fuel, fertilizer, herbicide, insecticide, seed, water, grazing, quality, nutrition, etc. on a site-specific basis to reduce waste and increase profits.
- An integrated agricultural management system incorporating several technologies and practices.



# Crop Management

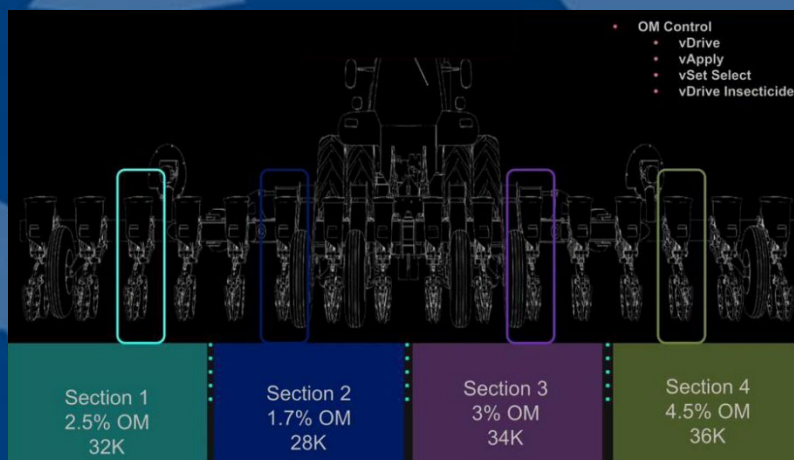
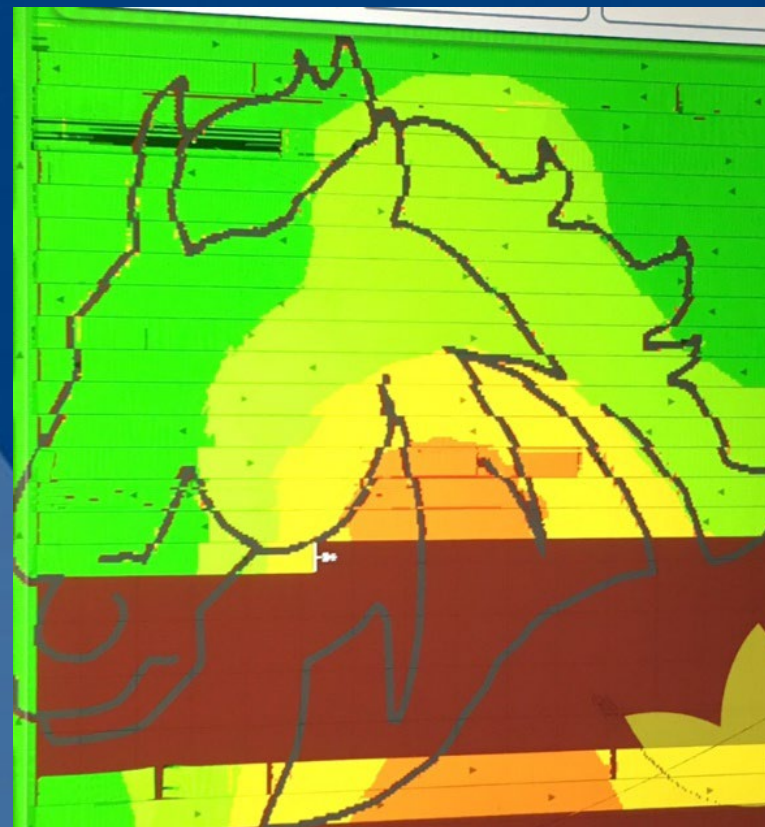
## *Precision Applications*





# Crop Management

## Precision Applications - Variable Rate (VRA) Populations



# Crop Management

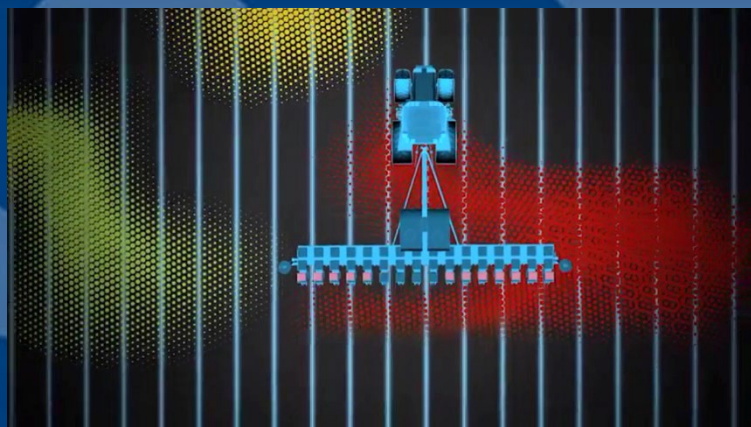
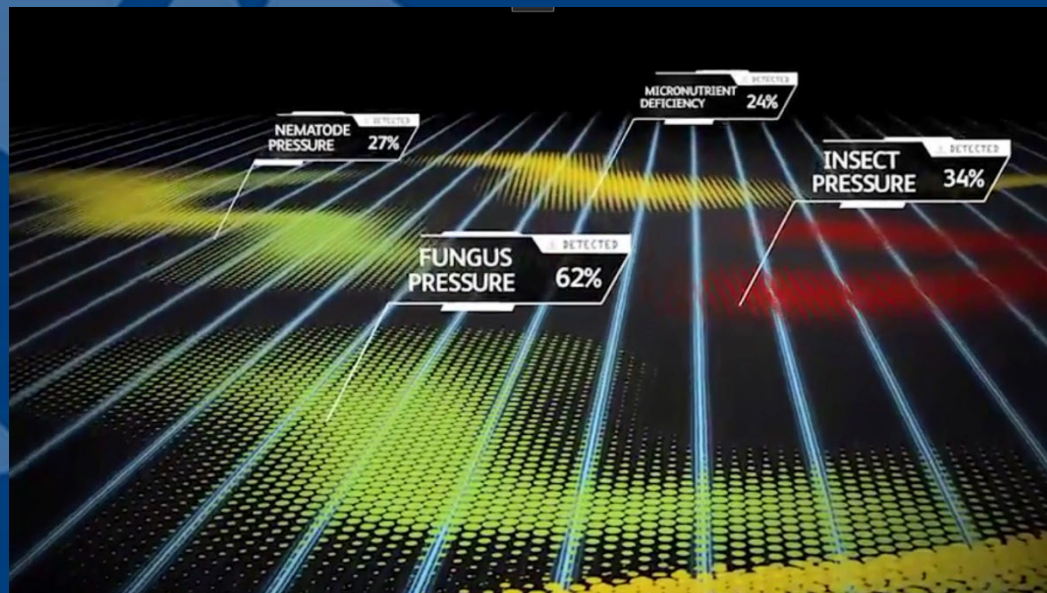
## Precision Applications - Variable Rate (VRA) Populations





# Crop Management

## Precision Applications - Variable Rate (VRA) Fertilizer and Chemicals





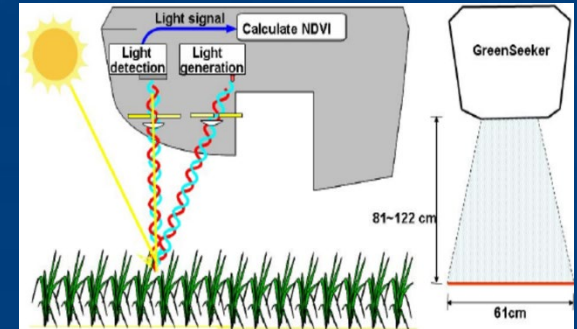
# Crop Management

## *Precision Applications - Variable Rate (VRA) Biologicals*



# Crop Management

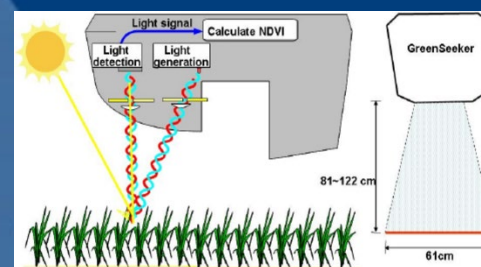
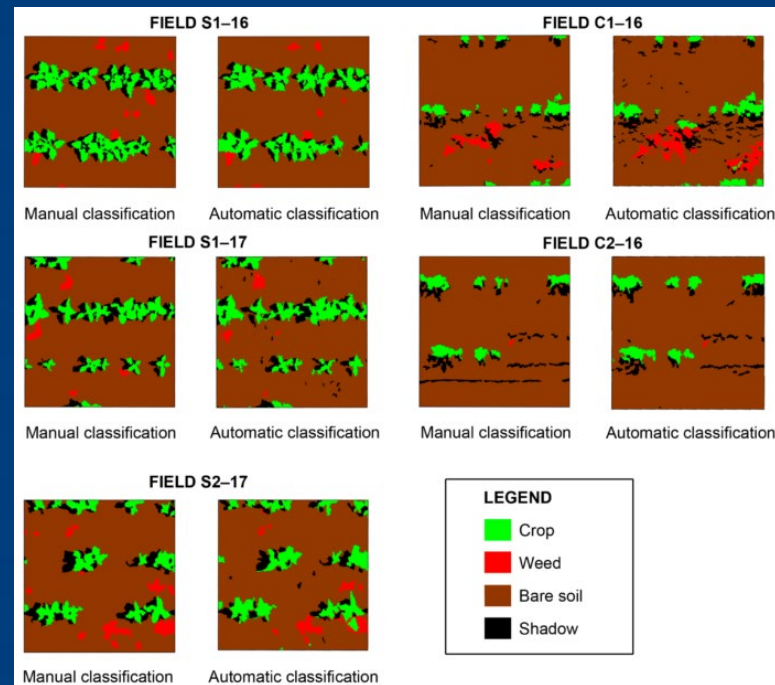
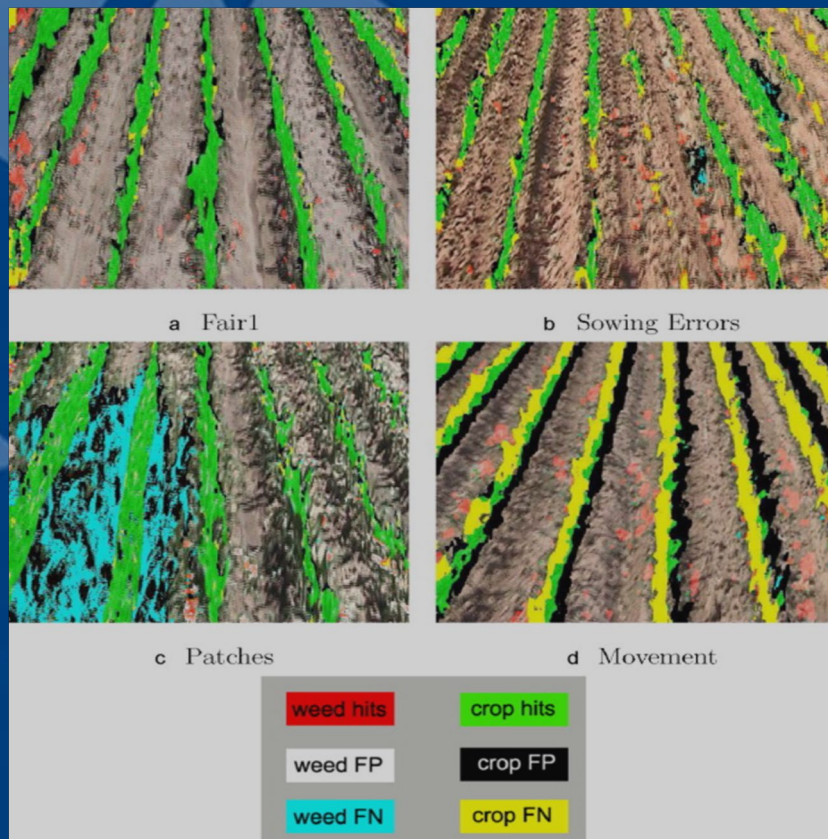
## Precision Applications – “See and Spray”





# Crop Management

## *Precision Applications – “See and Spray”*





# Crop Management

## *Tillage and Residue*

- Crop management decisions help conserve water
- Strip till, no-till, cover-crops, integrated cropping
- Crop and hybrid selection
- Seed, fertilizer and irrigation rates
- Weed control methods
- Improves water quality



# Crop Management

## *Water Quality and Erosion*



- Reduce nutrient runoff into ecosystems
- Reduce nutrient leaching into aquifers
- Reduce topsoil erosion





# Crop Management

## *Water Quality and Erosion*



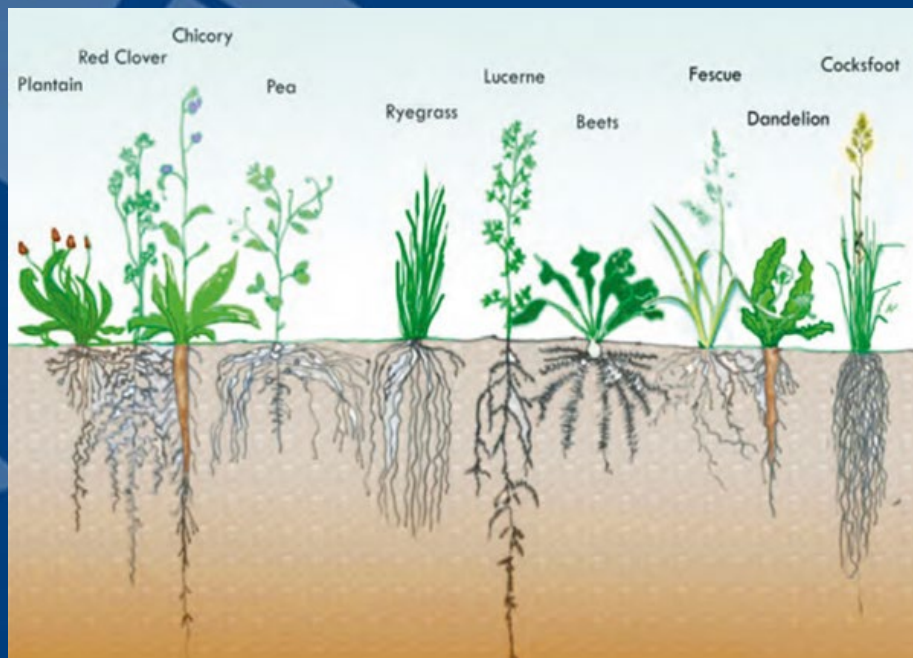
- Increase downstream municipal and public water quality
- Reduce algae blooms





# Crop Management

## Cover Crops



- Improve soil health
- Increase moisture and nutrient holding capacity
- Increase forage and feed options for livestock
- Prevent against soil erosion, water run-off, and evaporative loss
- Increase food nutrient density



# Crop Management

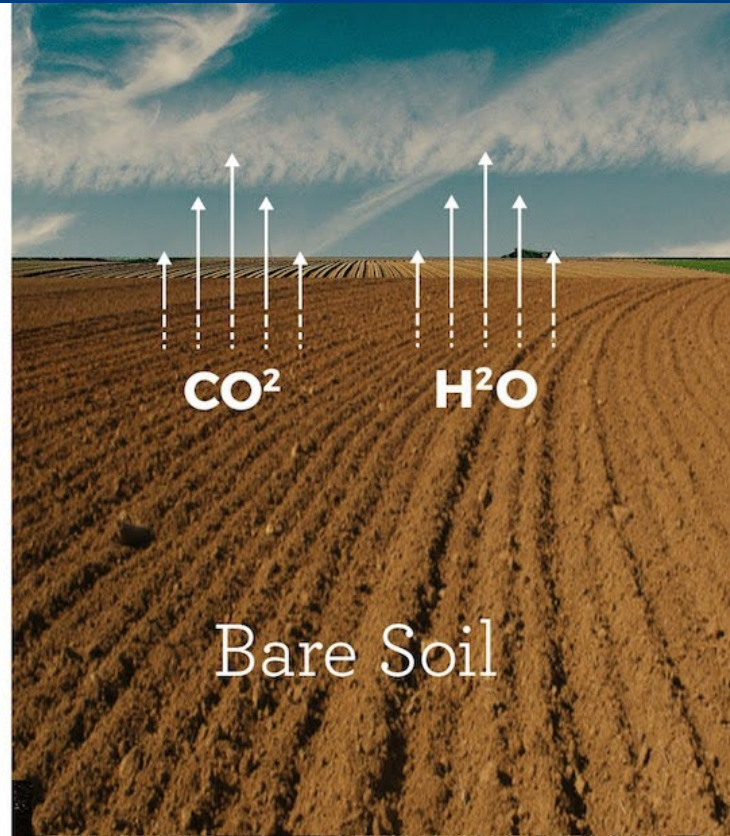
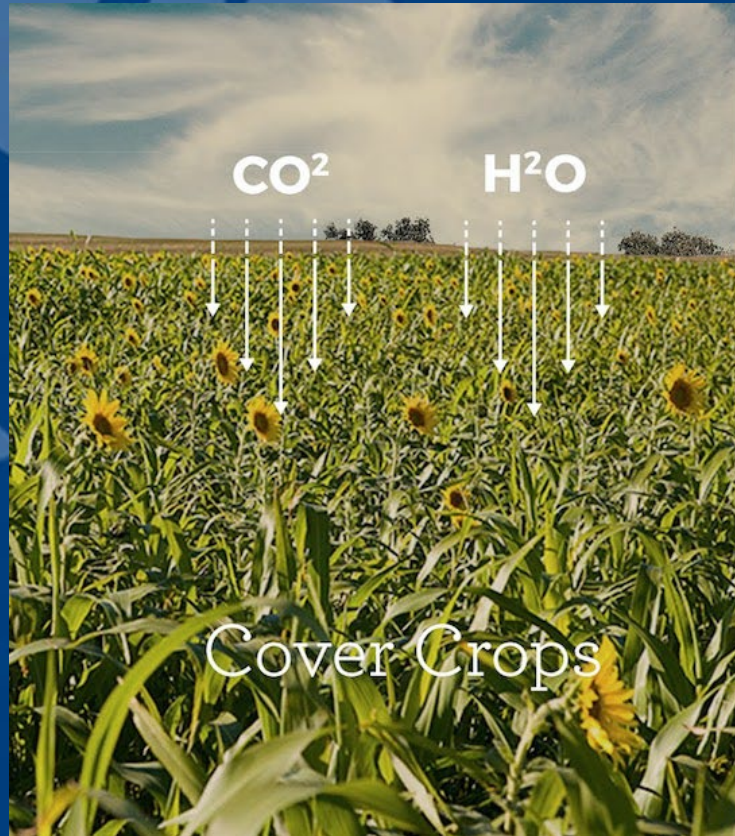
## *Cover Crops*





# Crop Management

## *Cover Crops*





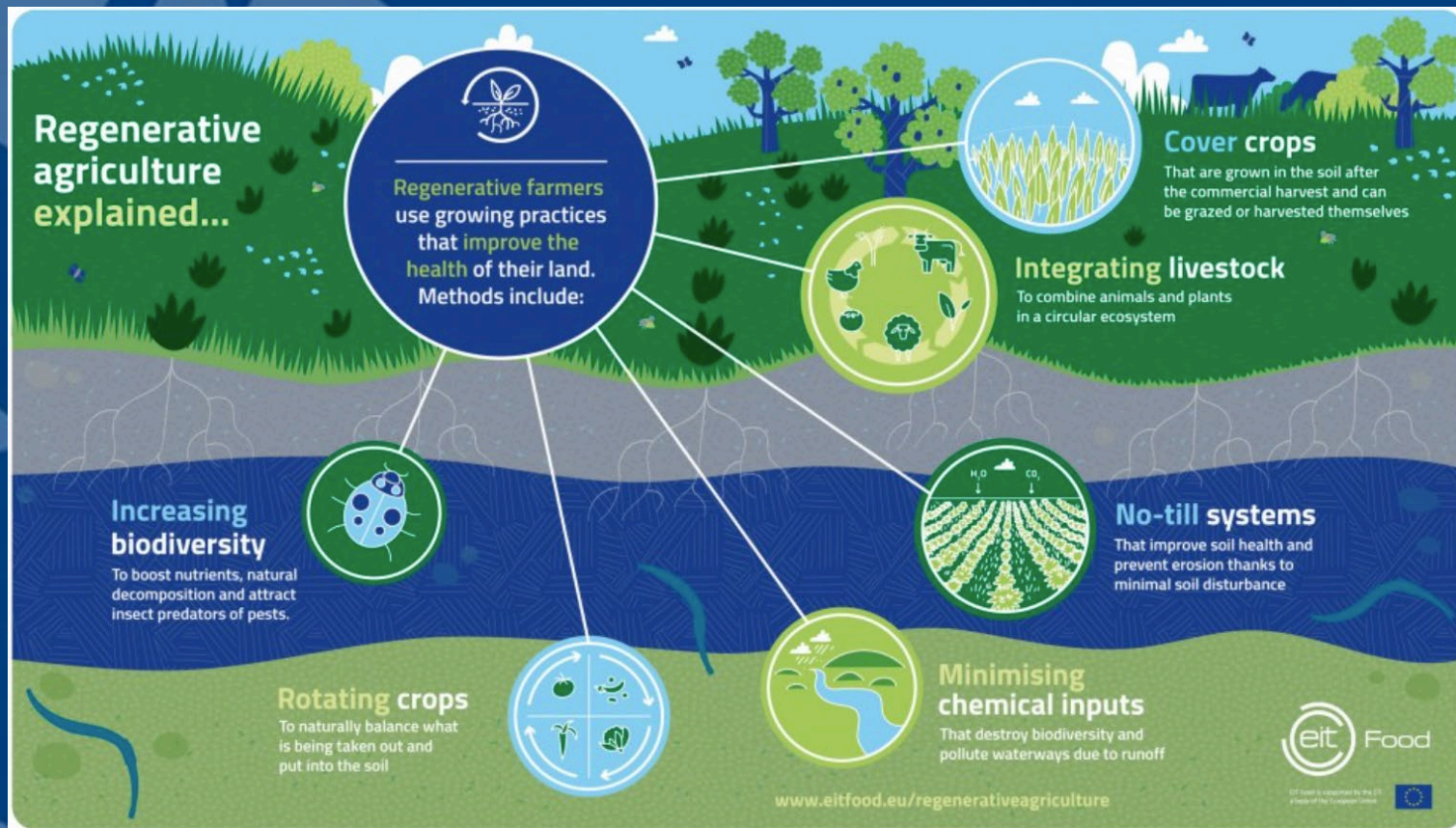
# Crop Management

## *Forage – Grazing*



# Crop Management

## Regenerative Practices





# Crop Management

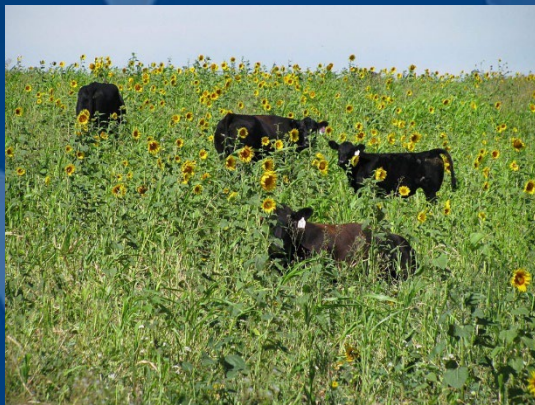
## *Regenerative Practices - Permanent Cover*





# Crop Management

## *Regenerative Practices - Grazing*



# Crop Management

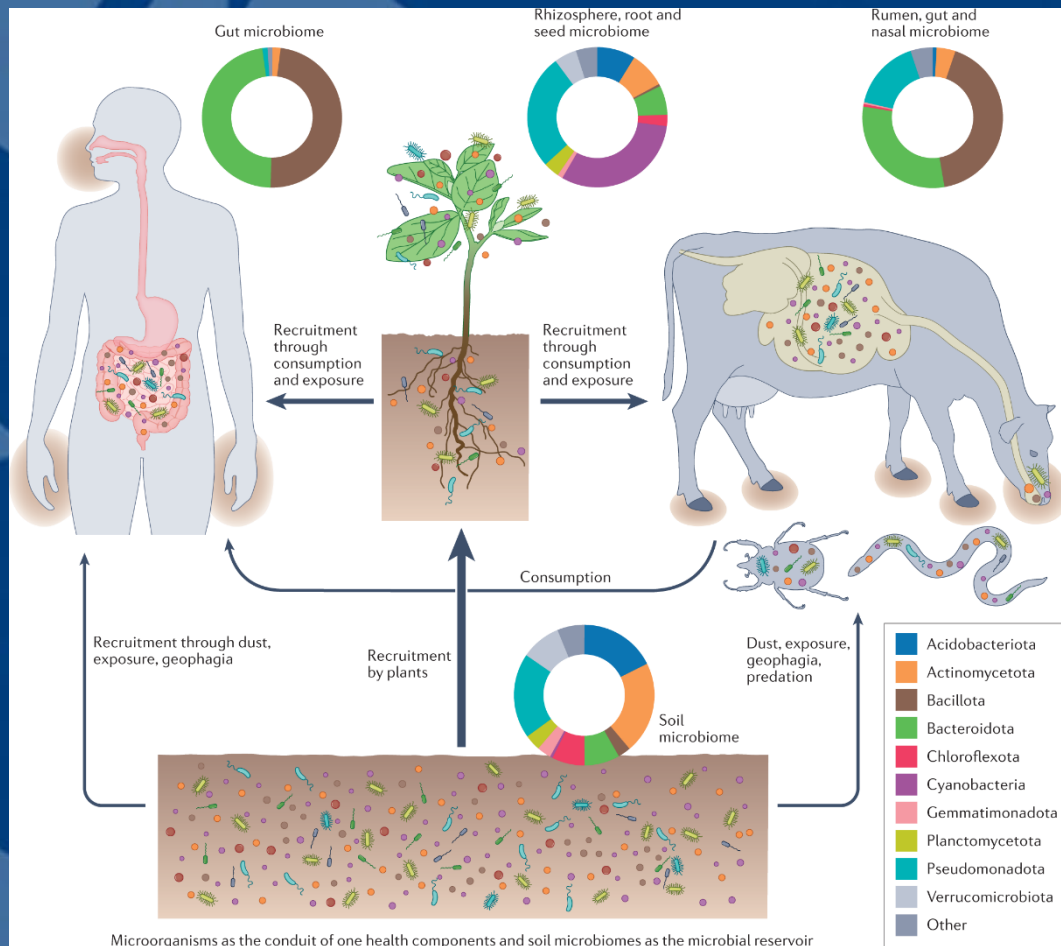
## *Forage – Flash Grazing*





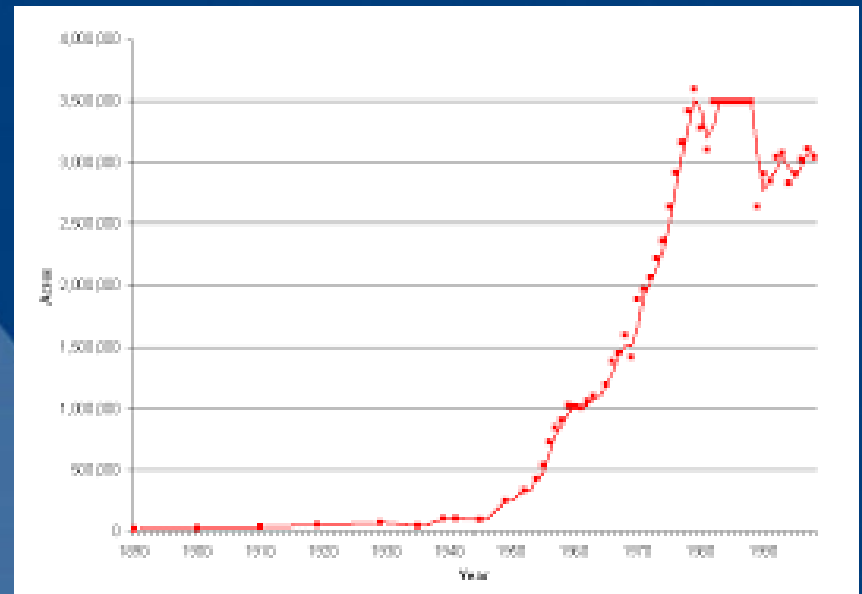
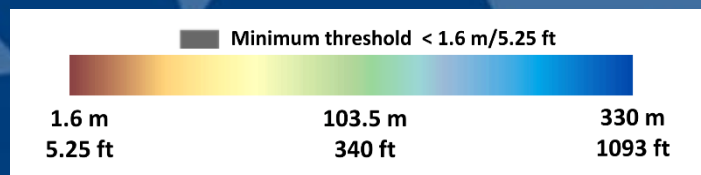
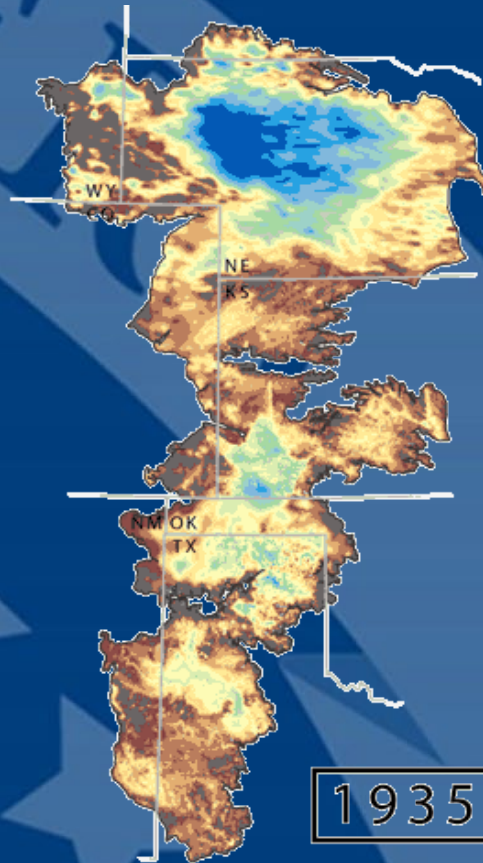
# Crop Management

## Regenerative Practices



# Geology

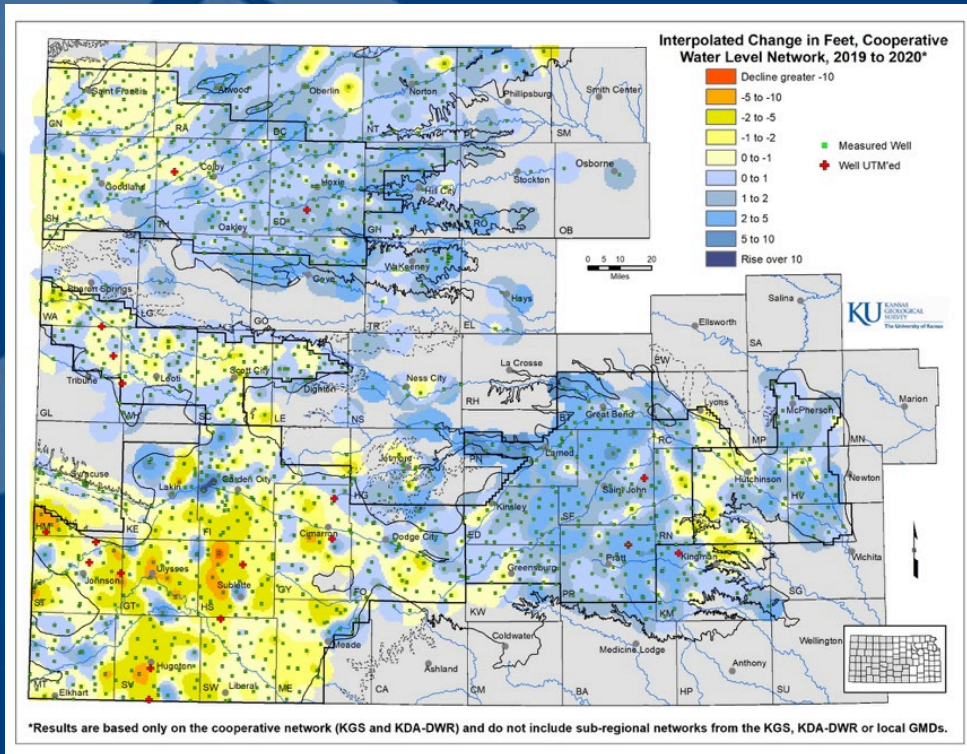
## The Ogallala Problem



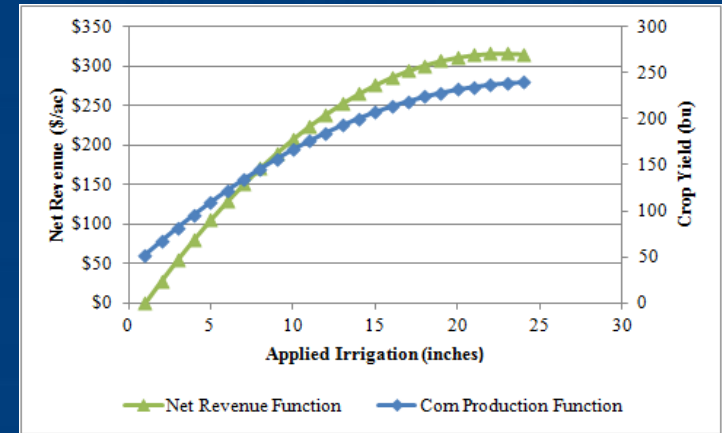


# Geology

## The Ogallala Problem



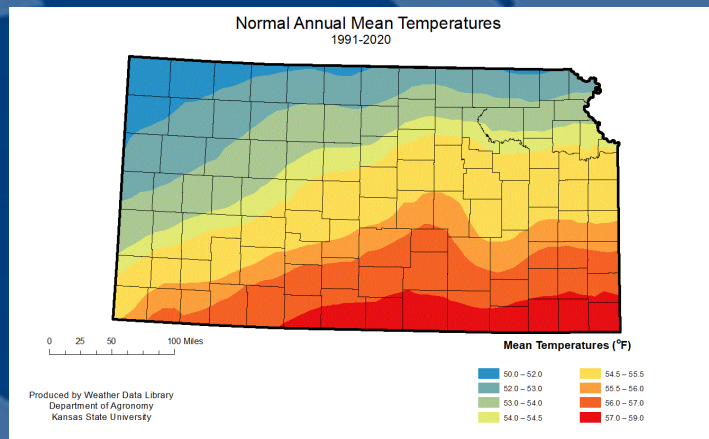
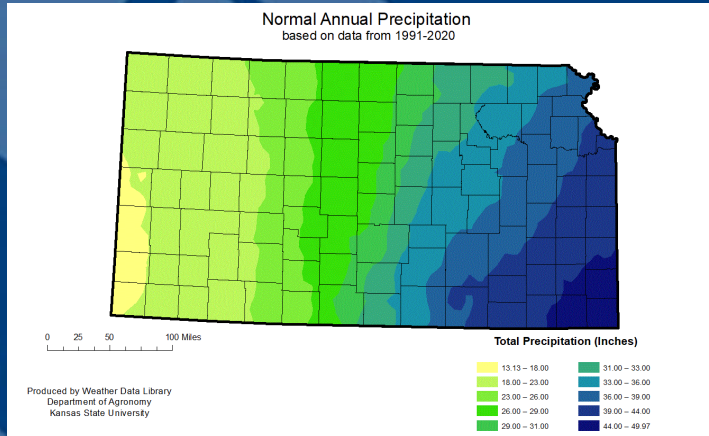
Based on research conducted by Dr. Bill Golden, funded in part by the Kansas Water Office under Contract # 15-0112, the USDA Ogallala Aquifer Project, and the U.S.D.A. – N.I.F.A. Ogallala Water CAP Project



Example from Southwest Kansas. Both curves exhibit diminishing marginal returns to applied groundwater. Curves vary by crop, location, precipitation, and time



# Climate





# Weather Monitoring



# Soil Moisture Monitoring

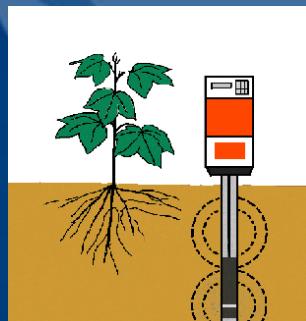
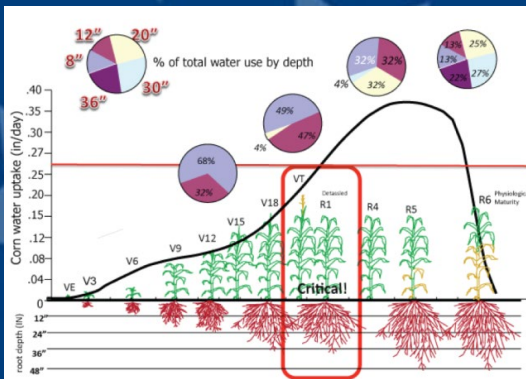
## Soil Probes





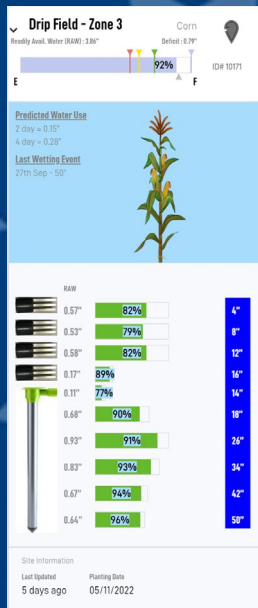
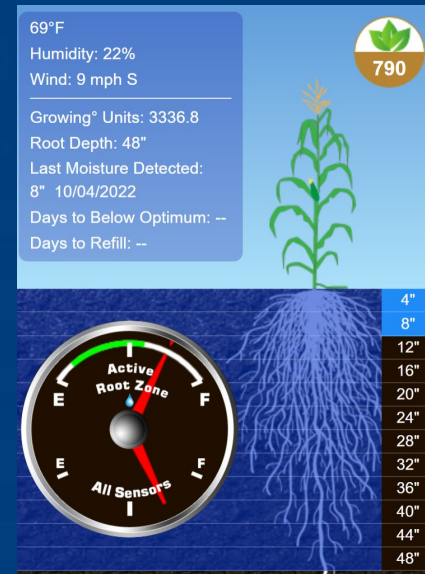
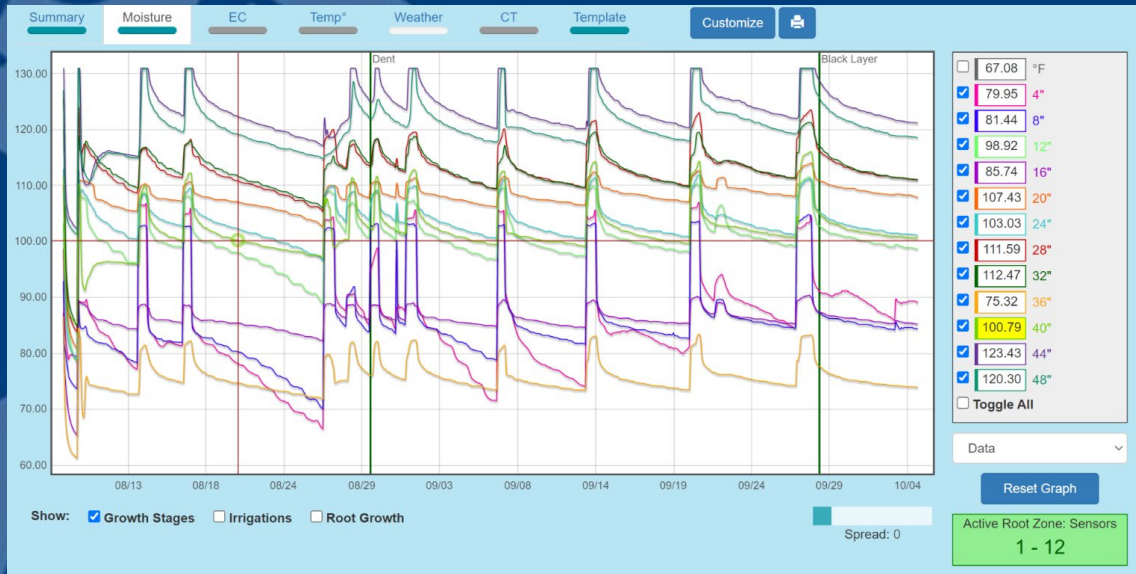
# Soil Moisture Monitoring

## Soil Probes



# Soil Moisture Monitoring

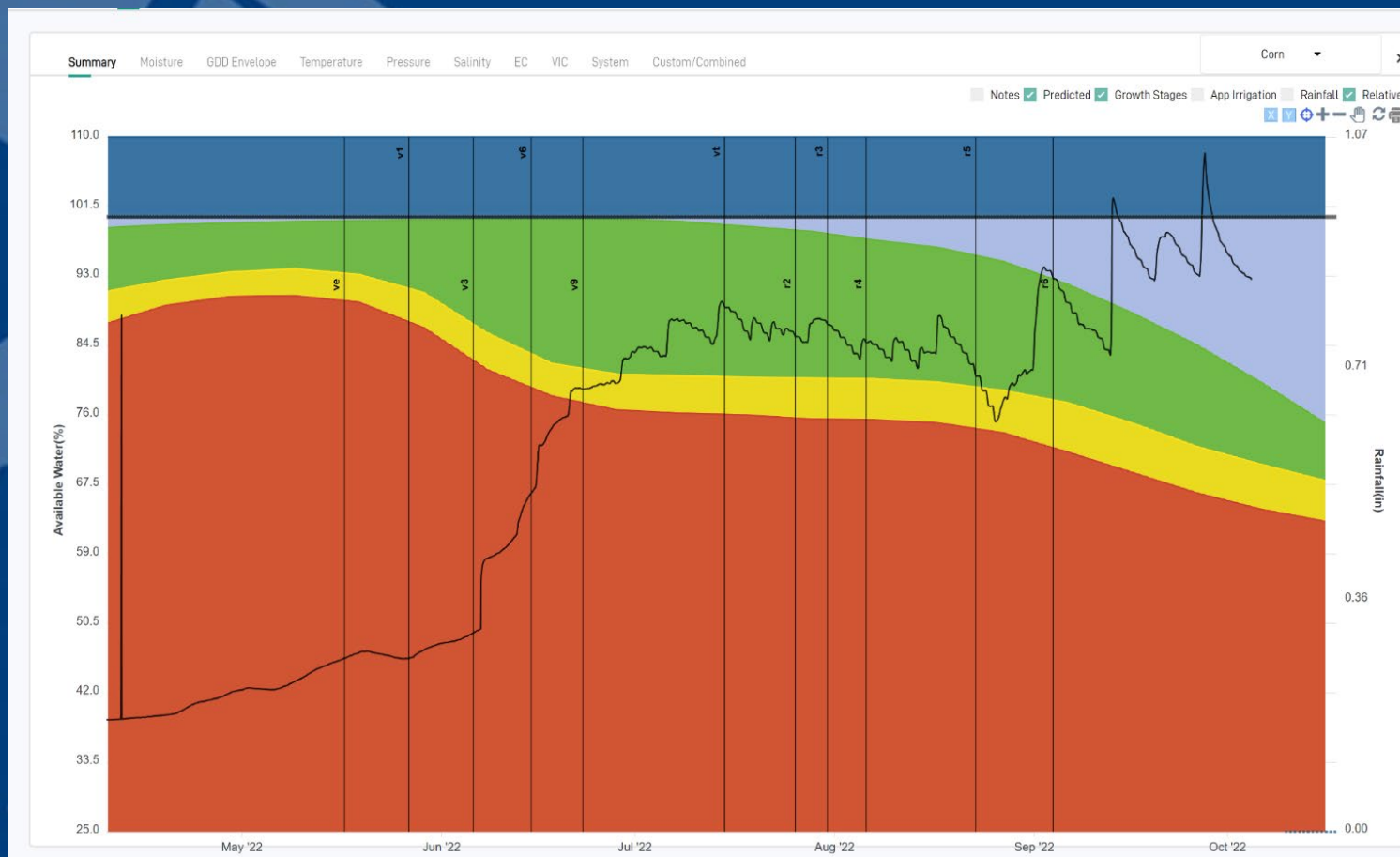
## Soil Probes





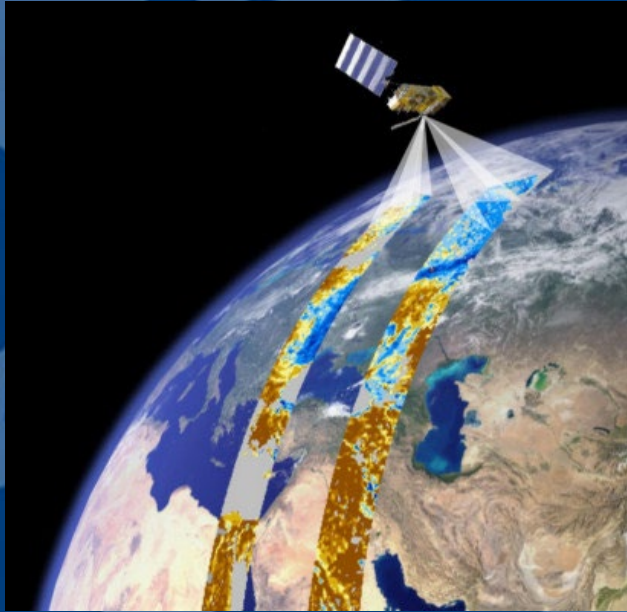
# Soil Moisture Monitoring

## Probe User Interface



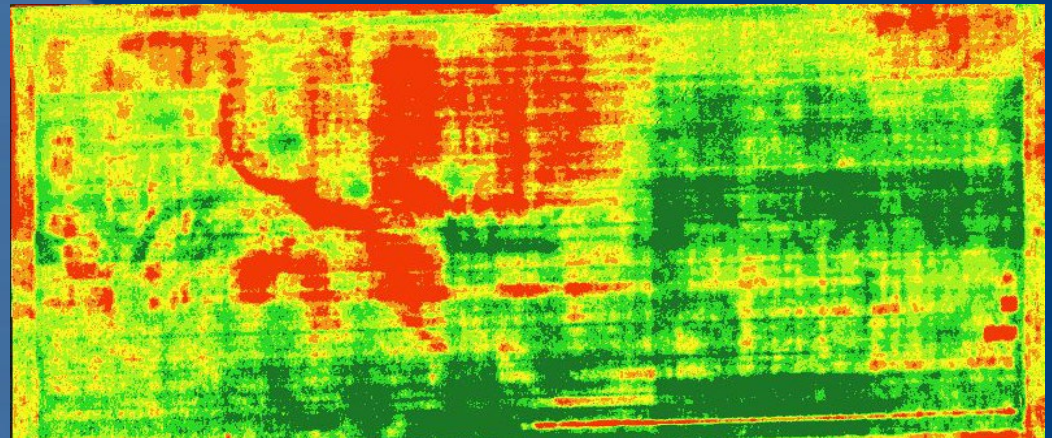
# Soil Moisture and Vegetation Monitoring

## Aerial Imagery (Remote Sensing)



### Platforms

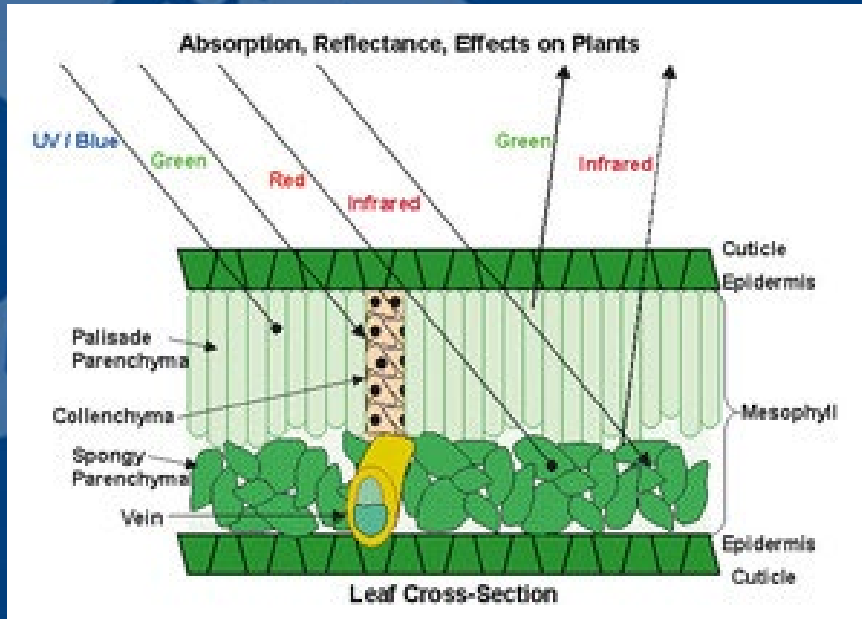
- Satellites
- Air Planes
- UAV/UAS (Drones)





# Soil Moisture and Vegetation Monitoring

## *Aerial Imagery (Remote Sensing) with Aircraft*



Value is the Ability to:

- Acquire a lot of information in a very short time
- With minimal labor input



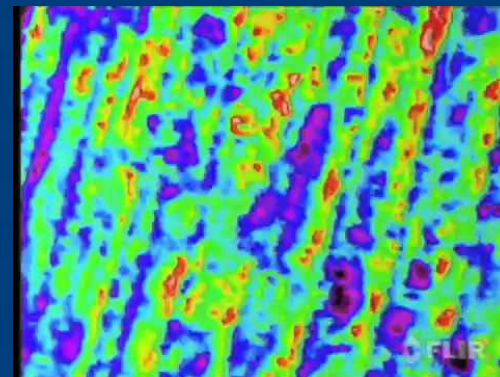
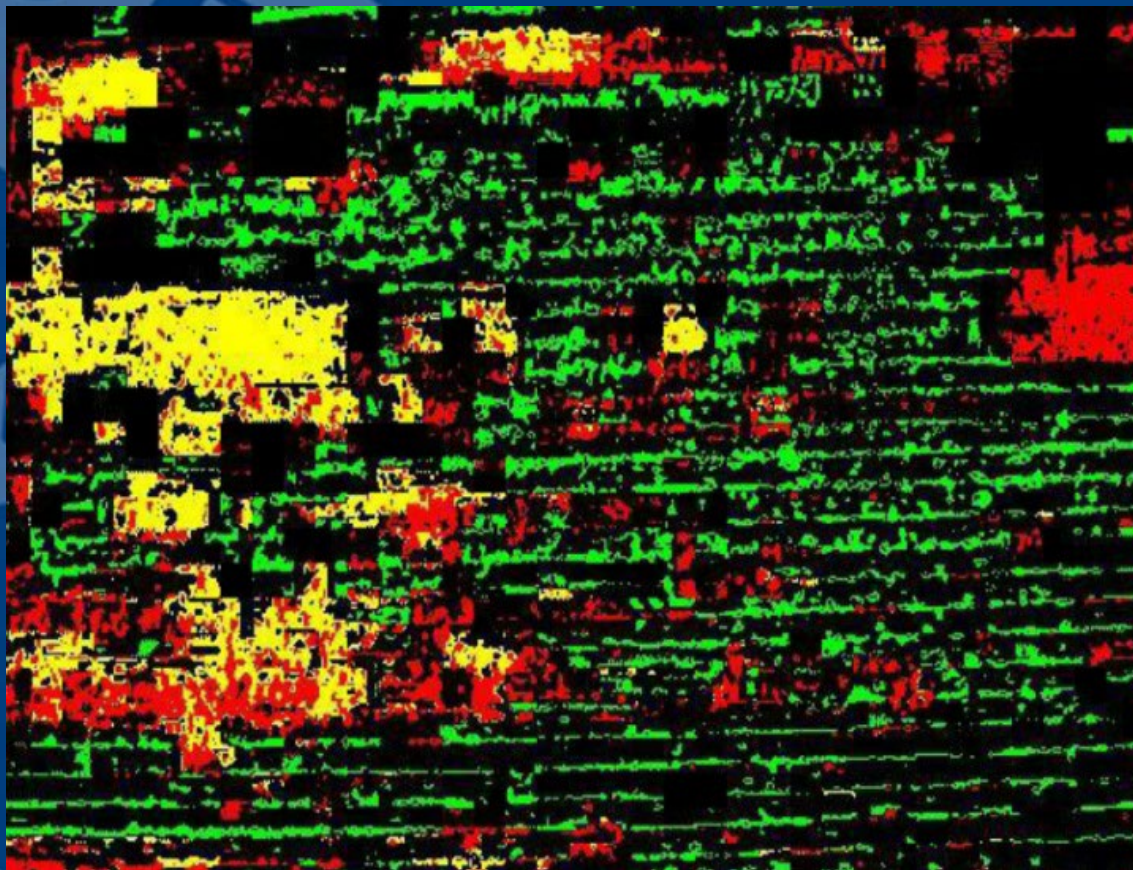
Used to:

- Detect insect damage
- Detect plant disease
- Detect weeds
- Detect moisture stress



# Soil Moisture and Vegetation Monitoring

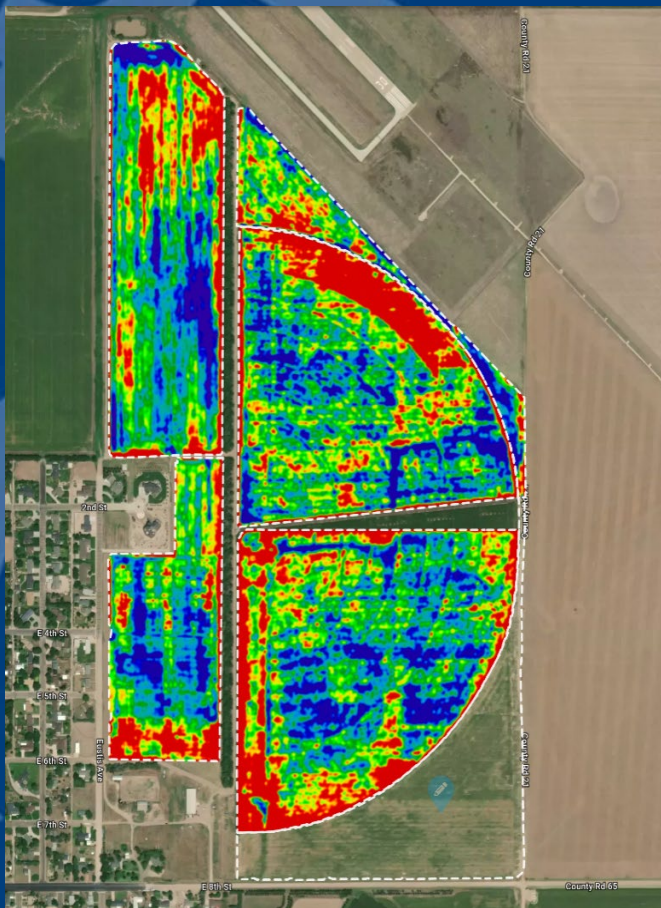
## *Aerial Imagery (Remote Sensing) with Aircraft*





# Soil Moisture and Vegetation Monitoring

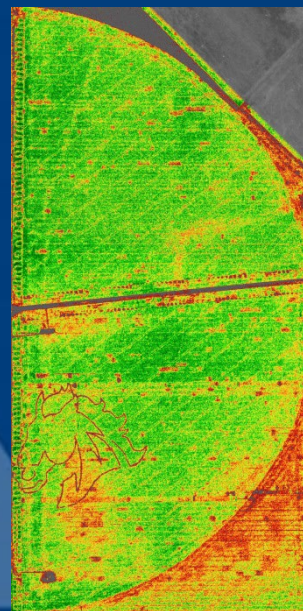
## *Aerial Imagery (Remote Sensing) with UAS*



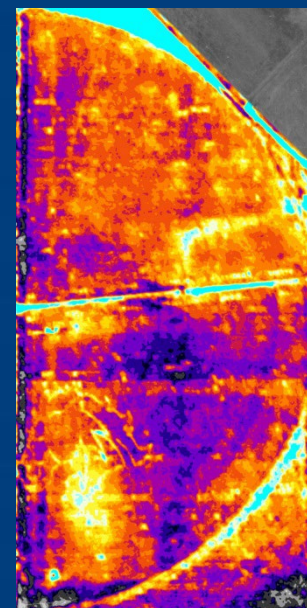
Water Stress



Color (RGB)



IR (NDVI)



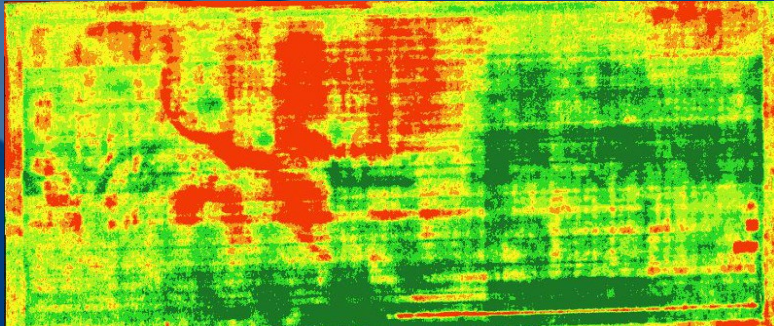
Thermal





# Vegetation Monitoring

## *Plant Sensors*





# Irrigation

## *Center Pivot – Nozzle Selection*



# Irrigation

## *Center Pivot – Mobile Drip Irrigation (MDI)*





# Irrigation

## *Variable Rate Irrigation*

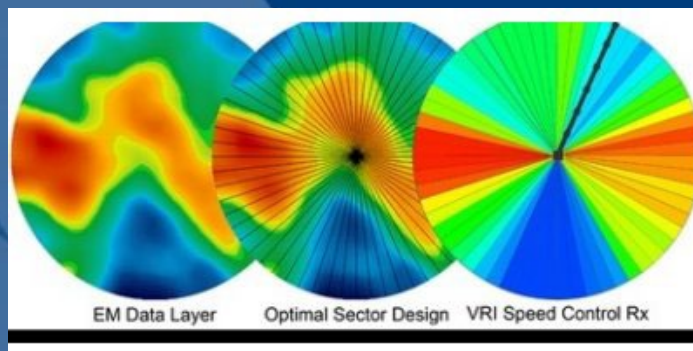


Apply varying rates of irrigation water based on the individual management zones within a field

Can save between 10%-15% of water usage per field

Based on speed or rate control

Reads GIS prescription map



# Irrigation

## Variable Rate Irrigation

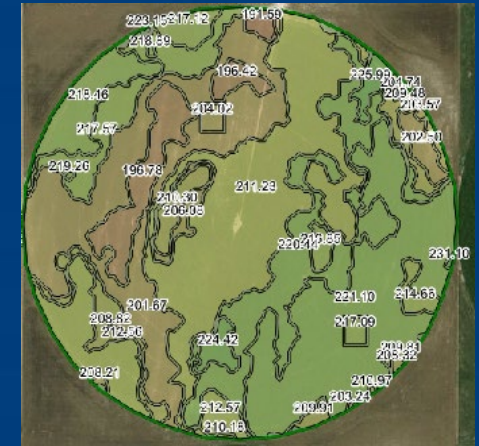
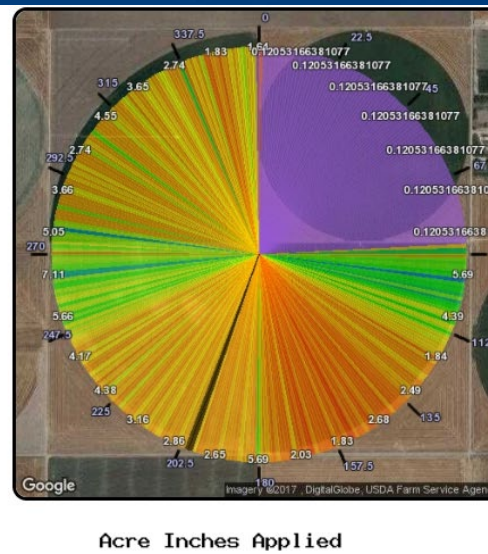
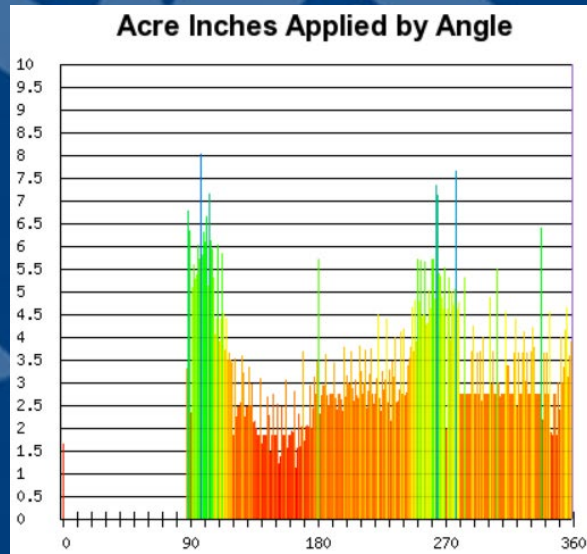
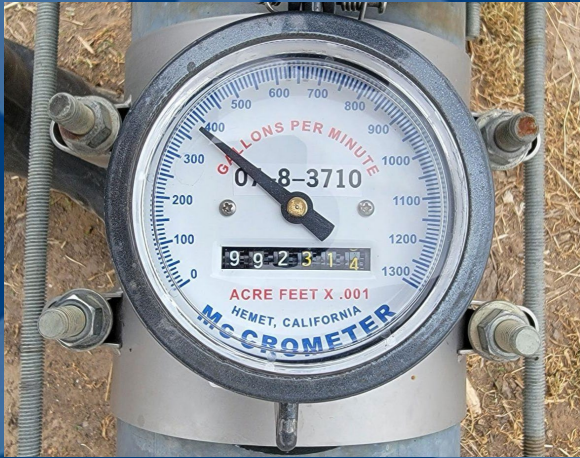


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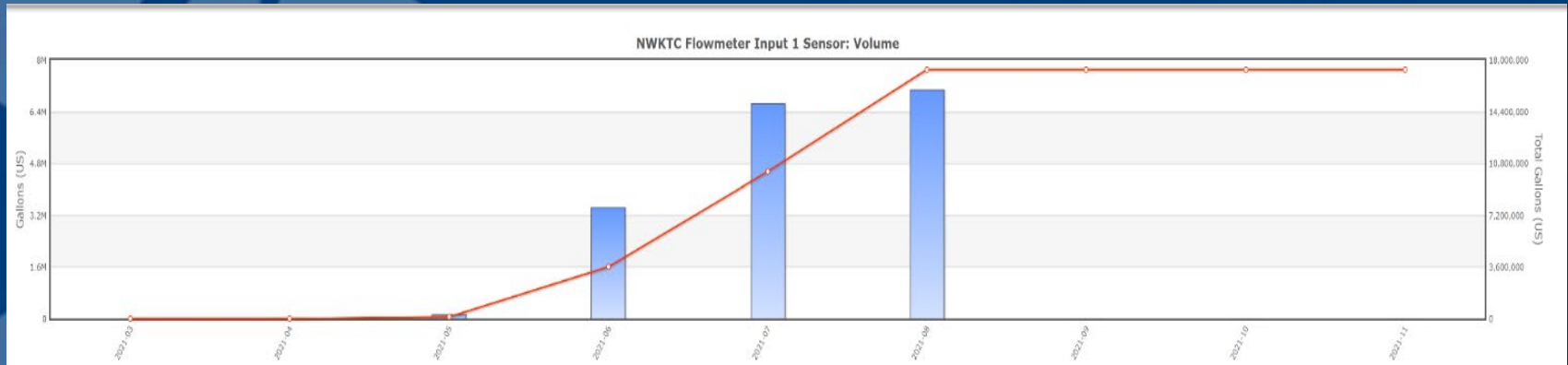
# Water Use Monitoring

*Digital or Analog*



# Water Use Monitoring

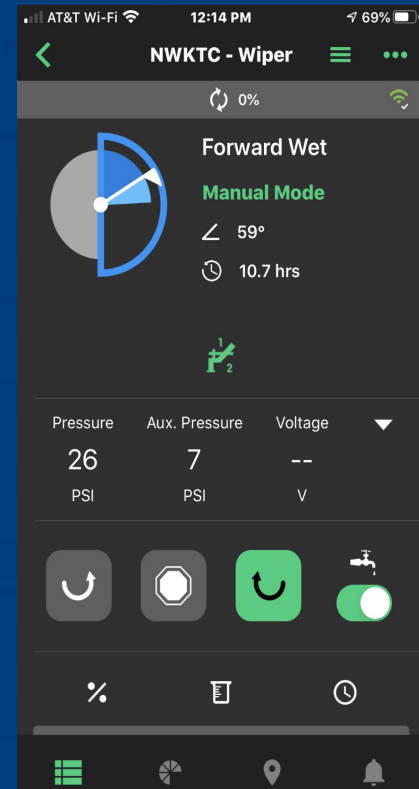
## Flow Meters





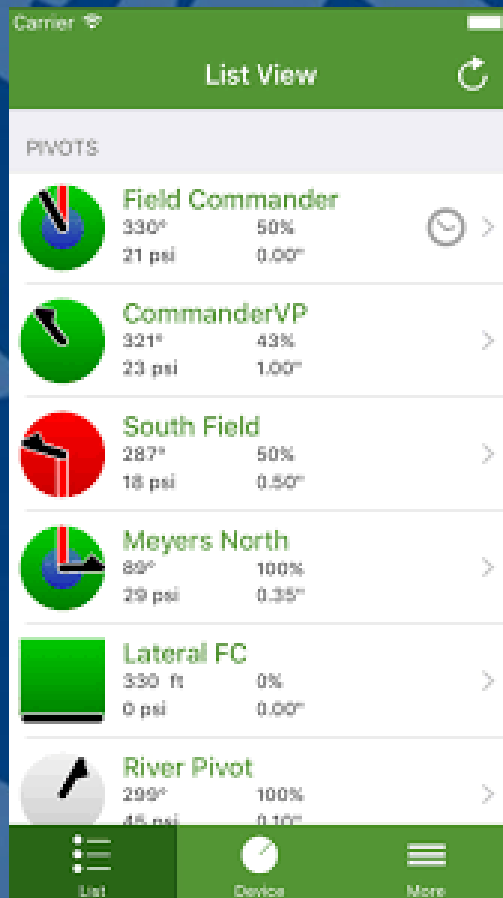
# Irrigation

## *Irrigation Control Systems*



# Irrigation

## *Irrigation Control Systems*





# Irrigation

## *Irrigation Control Systems*



# Irrigation

## *Irrigation Control Systems*





# Irrigation Methods

## *Subsurface Irrigation*

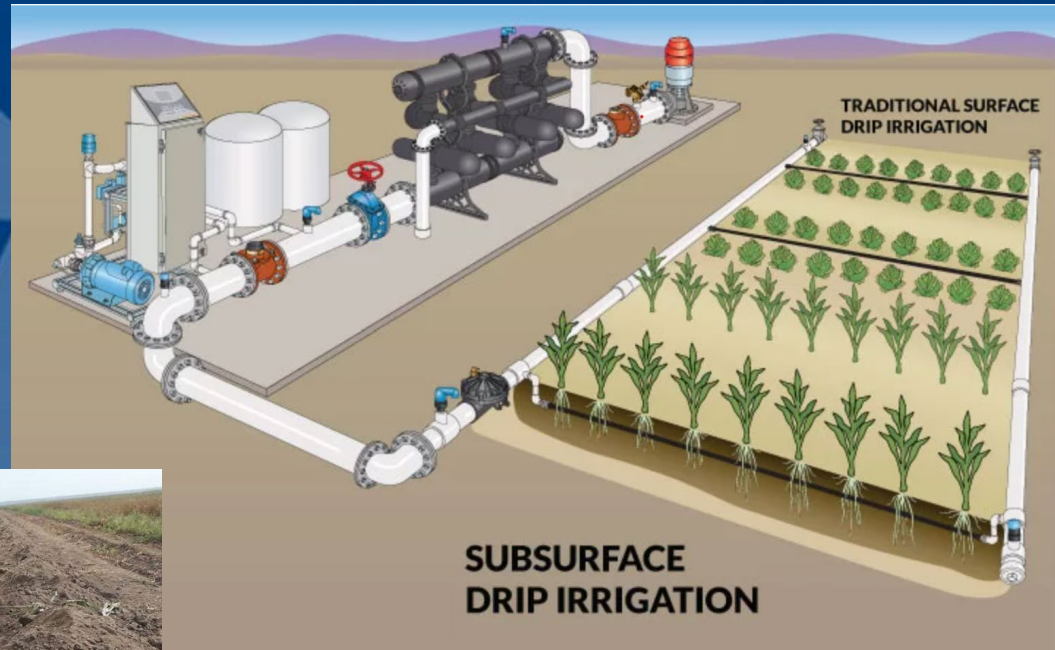


Image Source: <https://southernirrigation.com/2020/07/27/increase-yield-performance-with-subsurface-drip-irrigation/>





# Irrigation

## *Subsurface Irrigation*





# Water Reclamation

*Dairy*



# Water Reclamation

## Feed Yards





# Water Reclamation

*Industrial/Commercial*



# Education



- WISE Tours
- Field Days
- Product/Service Demos





# Education

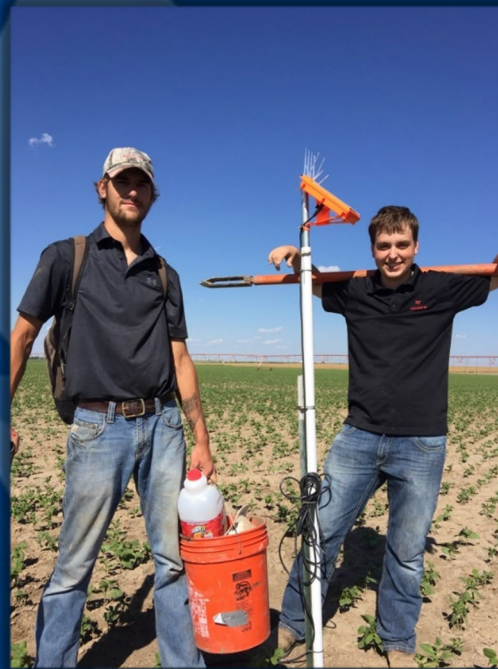
- Producer Training
- Stakeholder Roundtable Meetings
- Master Irrigator





# Education

- Workforce Development
- Higher-Education





# Education



- Agency/Organization Coordination
- Agency/Organization Training
- State-wide Advisory Board
- Innovation Cost-share Program



# Program Overview

## *Partnerships and Collaborations*

### K-State/CSU-IIC

- USDA-AFRI Climate Hub Grant
- Farm of the Future Grant

### NWKTC

- NRCS-CED Grant

### Master Irrigator

- GMD4
- CSU-IIC
- K-State
- OSU
- NPGCD
- Syngenta





# Program Overview

## *Partnerships and Collaborations*

### Training Events

- PLJV/NRCS – Irrigation Training
  - NRCS
  - GMD4/GMD1
  - PLJV
  - NWKTC
  - KGS
  - KWO

### Public Interest Projects

- Advanced Water Metering Platform (Bestifor/Larson)
  - GMD1, GMD3, GMD4, DWR
- State-wide/Regional IoT and LoRa Network (Viaanix/Goerring)
  - GMD4, DWR, KWO, KDC



# Program Overview

## *Partnerships and Collaborations*

### Industry Coordination

- Requesting supplier equipment displays
- Requesting special pricing packages
- Attending equipment demonstrations
- Conversations with producers about what's working

### Plugging In

- Pheasants Forever
- Ducks Unlimited
- Playa Lakes Joint Venture (PLJV)
- KDA-Division of Conservation (DOC)
- DOC Workgroups
- County Conservation Offices
- Natural Resources Conservation Service (NRCS)
- Groundwater Management Districts (GMD's)
- KDA-Division of Water Resources (DWR)
- Kansas Geological Survey (KGS)
- K-State University





# Program Overview

## *Projects*

- Northwest Kansas Technical College
- Highland Community College
- Goossen Farms
- Woofter Farms
- Homeland Farms
- Long Farms
- Circle C Farms
- WaterPACK/ILS
- Janssen Farms
- Brady Farms
- Goering Farms
- Bestifor Farms
- Loess Hills
- Westside Dairy
- Cactus Feeders
- Ulysses Golf Course



# Program Overview

## *Budget Review*

Water Technology Farms (High Plains Aquifer)

- Appropriated total FY2023 : \$326,402
- Allocated to projects (December 1, 2022): \$156,423





# Program Overview

## *Outreach and Media*

WISE Tour (March 2023)

- Retired Winter Expo (legacy)

WISE Farm Field Days (Summer 2023)

Branding

- New WISE Logo

Social Media

- WISE Facebook account
- WISE Twitter account

Field Signage

- New logo
- QR code for virtual tour and up-to-date project information
- Solar lighting

Website

- Look for updated content in 2023



# Program Overview

- Alumni
- Advisory Group
- Regional Round-table Discussions
- Implementation





# Questions?



# Thank you!

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