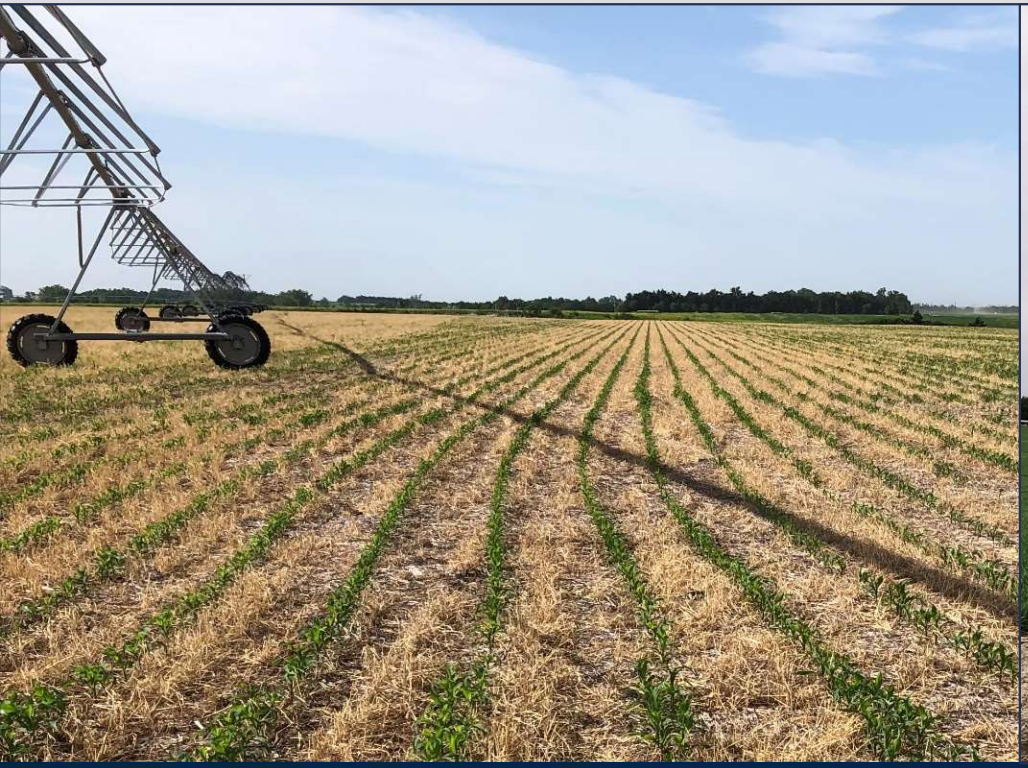


COVER CROP IMPACT STUDY

Prepared for:

Nebraska Groundwater Monitoring Council

Prepared by:

CPNRD
CENTRAL PLATTE NATURAL RESOURCES DISTRICT

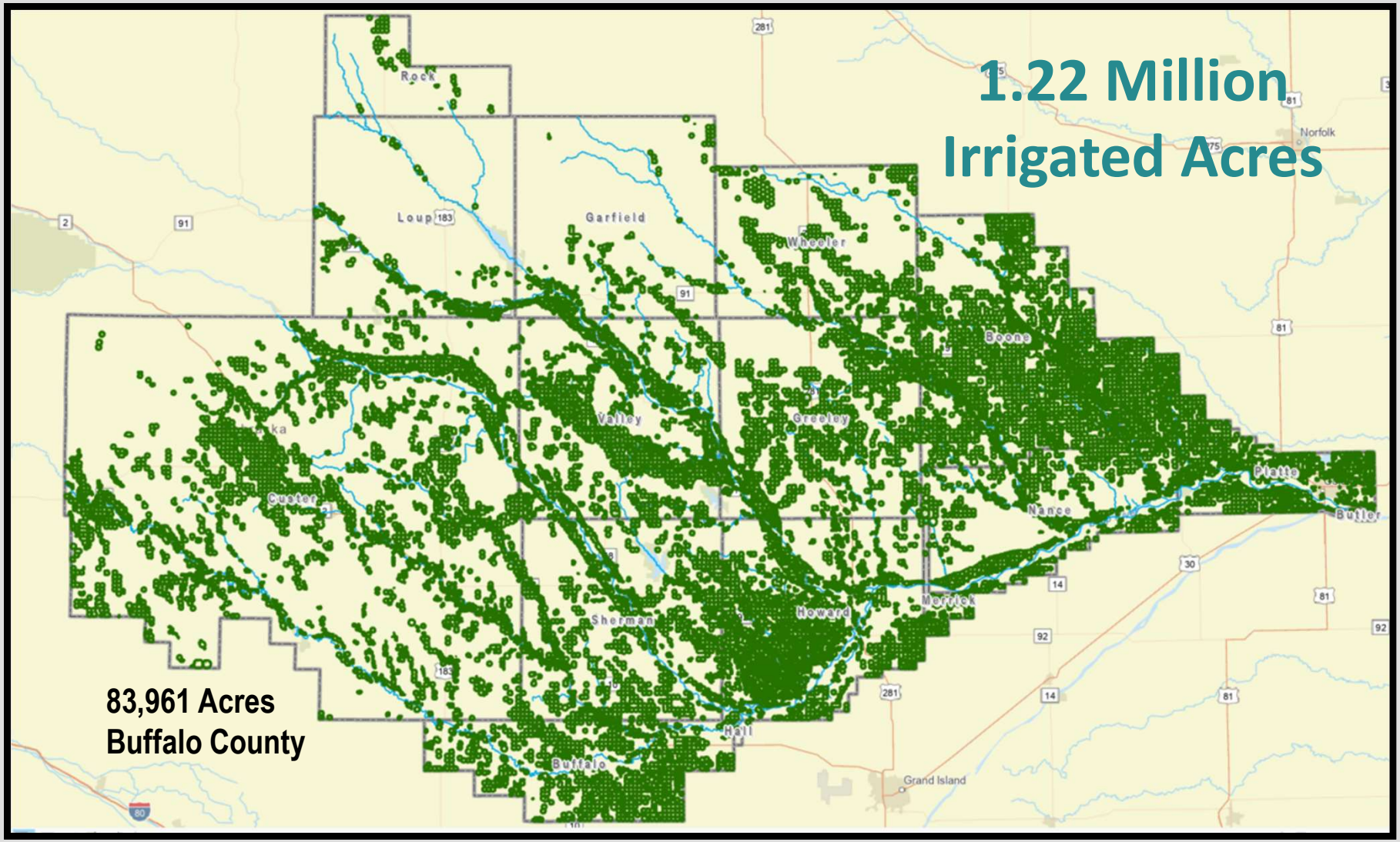
LOWERLOUP
NATURAL RESOURCES DISTRICT

EA Engineering, Science, and Technology, Inc., PBC

April 16, 2024

Information on the LLNRD & CPNRD

LLNRD – Irrigated Acres



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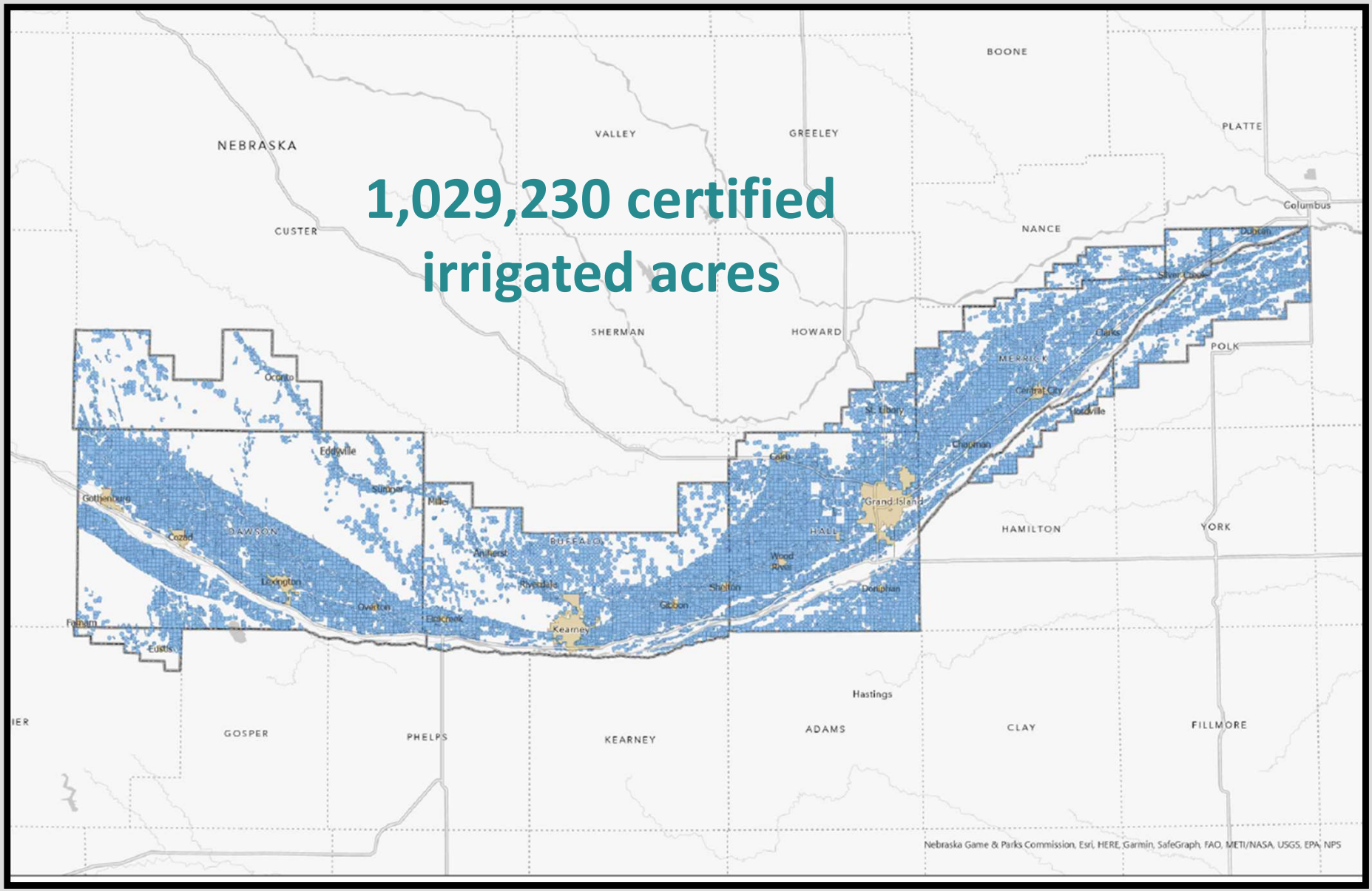
CPNRD – Irrigated Acres



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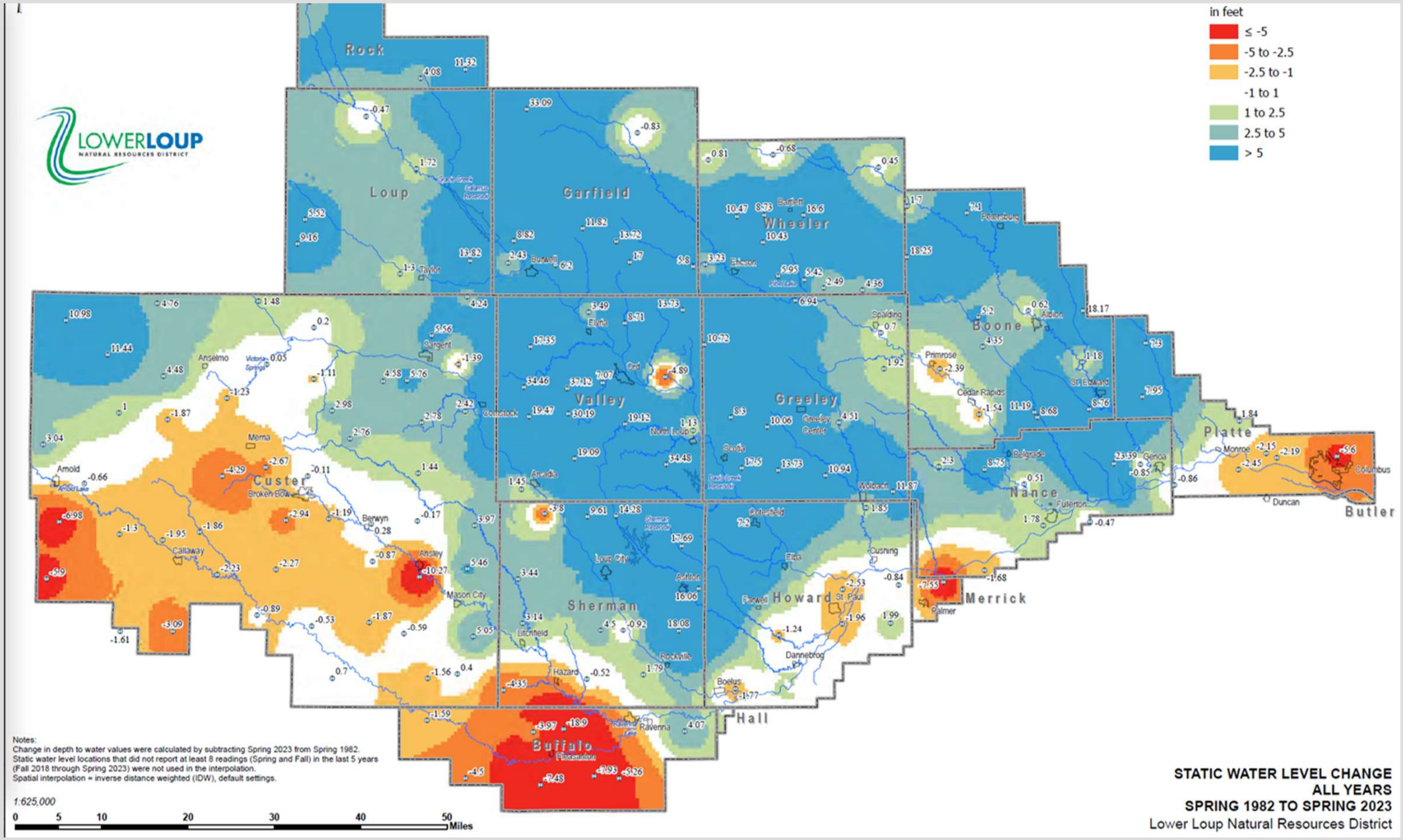
Static Water Level Change: Spring 1982 to Spring 2023



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Recharge Potential

South Loup Basin, Buffalo County

- ✓ **Potential for recharge projects**
  - Ravenna Lake
  - Retention cells, ponds
  - Diverting water, terraces
  - Smaller Reservoirs upstream in Upper Loup NRD west of Arnold
- ✓ **Farming Practices**
  - Land use
  - Cropping strategies
  - Water usage

Typical Impacts of Cover Crops

- Increase soil organic carbon / improve soil quality
- Reduce soil erosion
- Weed suppression
- Insect/Pest control
- Increase infiltration/reduce runoff
- Reduce nitrate leaching

Still some questions/data gaps on some impacts:

- Evapotranspiration?
- Deep percolation / Recharge?

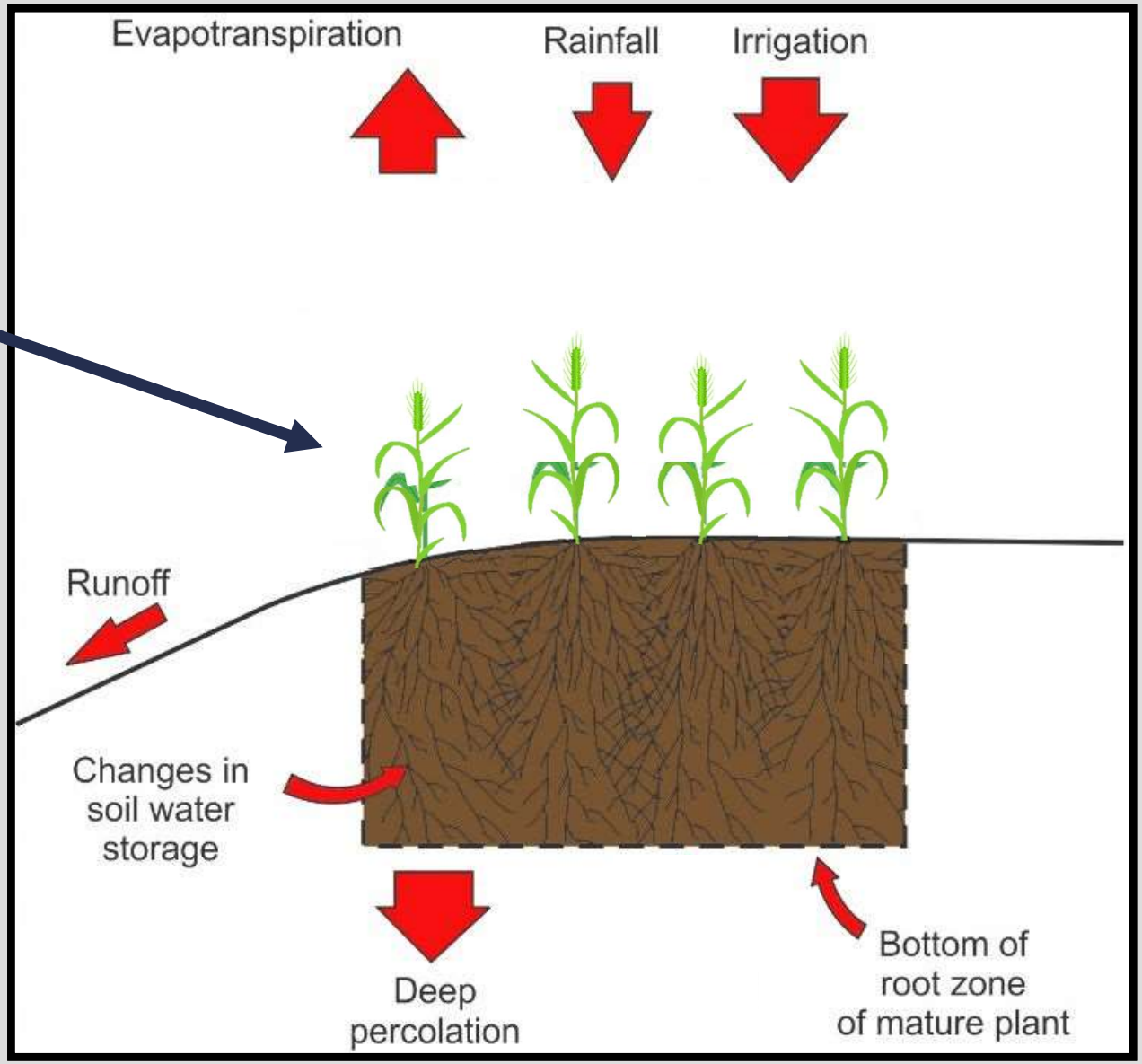
Benefits of Studying Cover Crops

A better understanding of these impacts would assist the NRDs with the following:

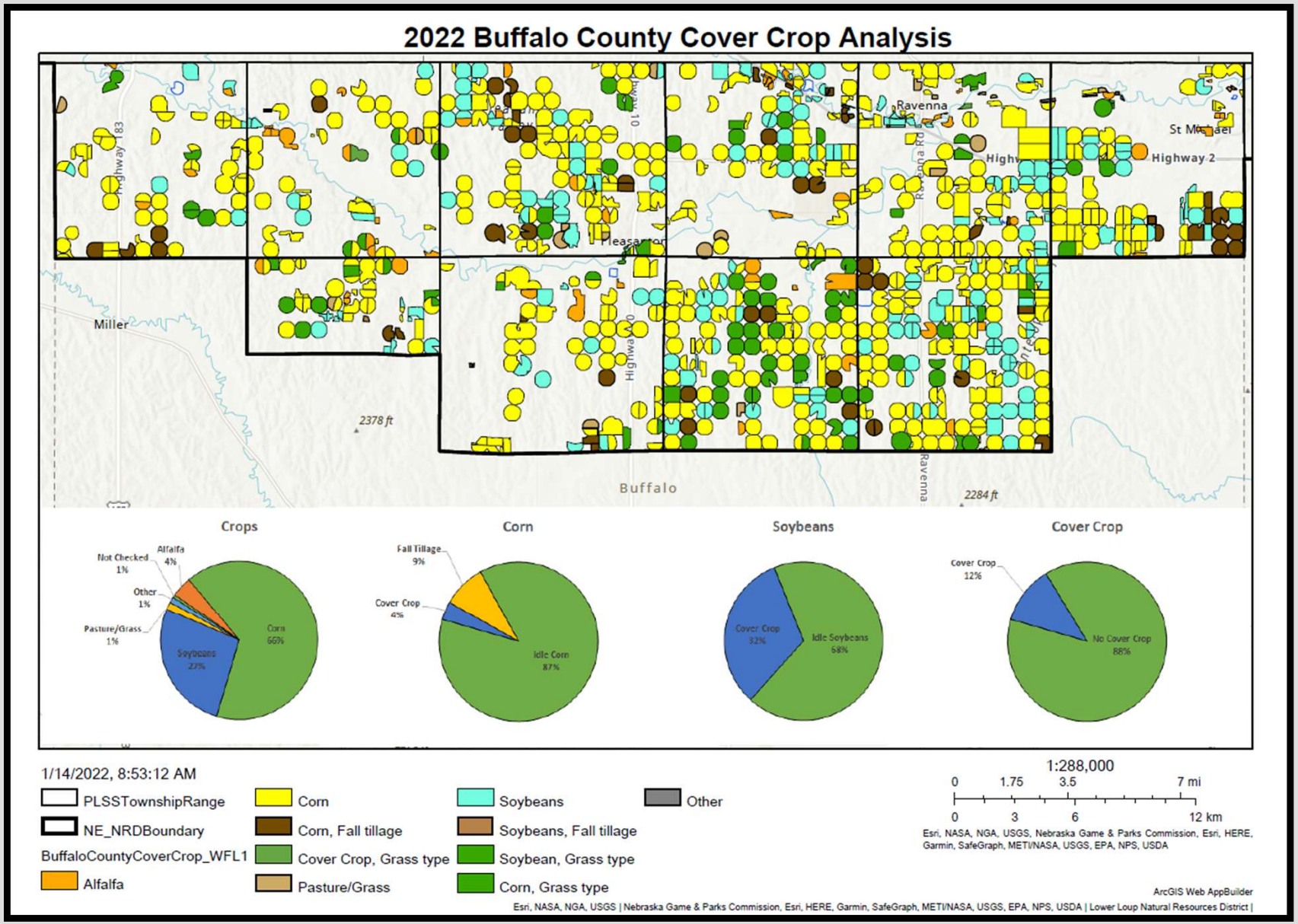
- Making informed management decisions regarding promotion of cover crop management programs based on quantifiable results.
- Allow for adjustments of existing models to more accurately simulate the long-term impacts of using cover crops.
- Establish a baseline for impacts of common cover crop management practices and identify/evaluate changes in cover crop management practices for future implementation.

Cover Crops – Soil Profile

Imagine this is your cover crop



Cover Crop Analysis



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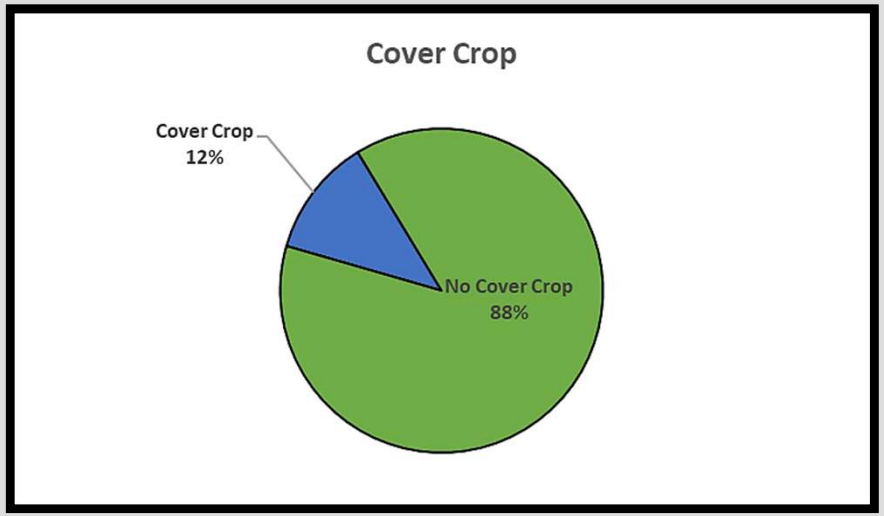
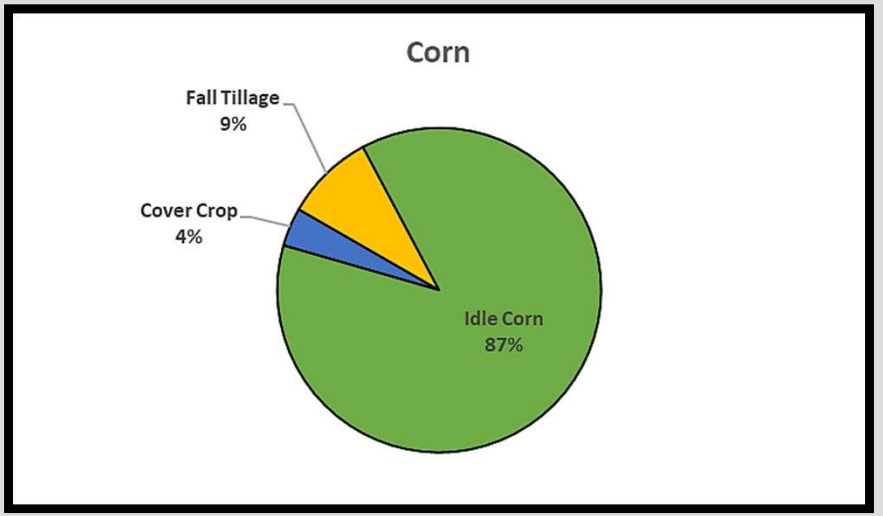
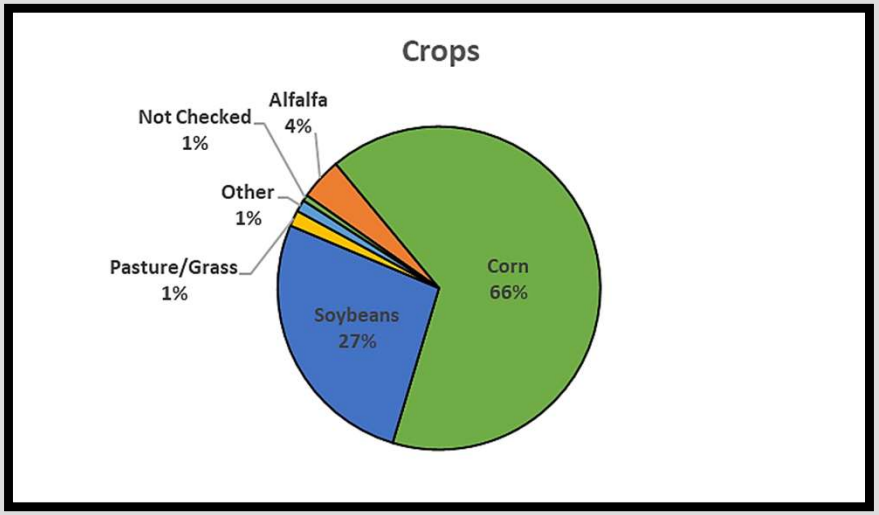
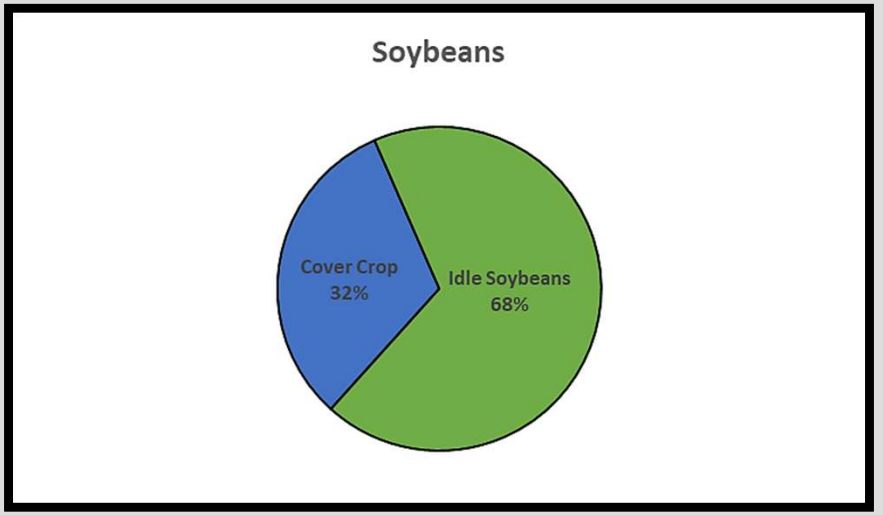
Cover Crop Analysis









Literature Review

Literature Review conducted for this study:

- There is considerable research on the impacts cover crops have on:
  - Crop yields
  - Improvement to soil health
- But limited information that quantifies the impact of cover crops on groundwater recharge (EA, 2017).

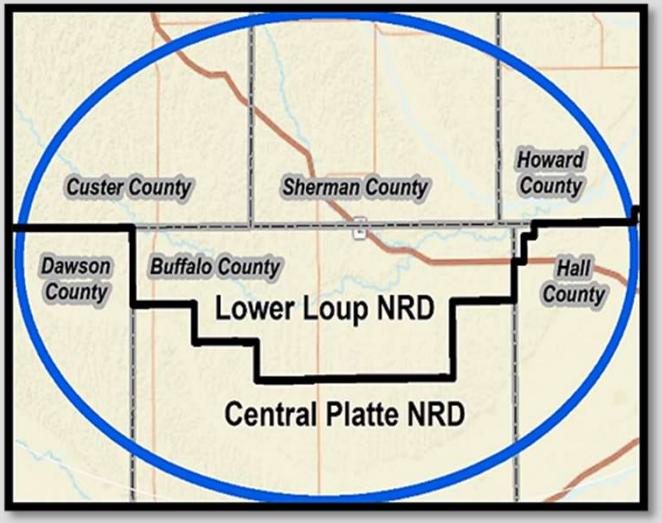
Project Objective

Develop and implement a **scientifically defensible** and **practical** study that will increase the understanding of the general influence of cover crops on:

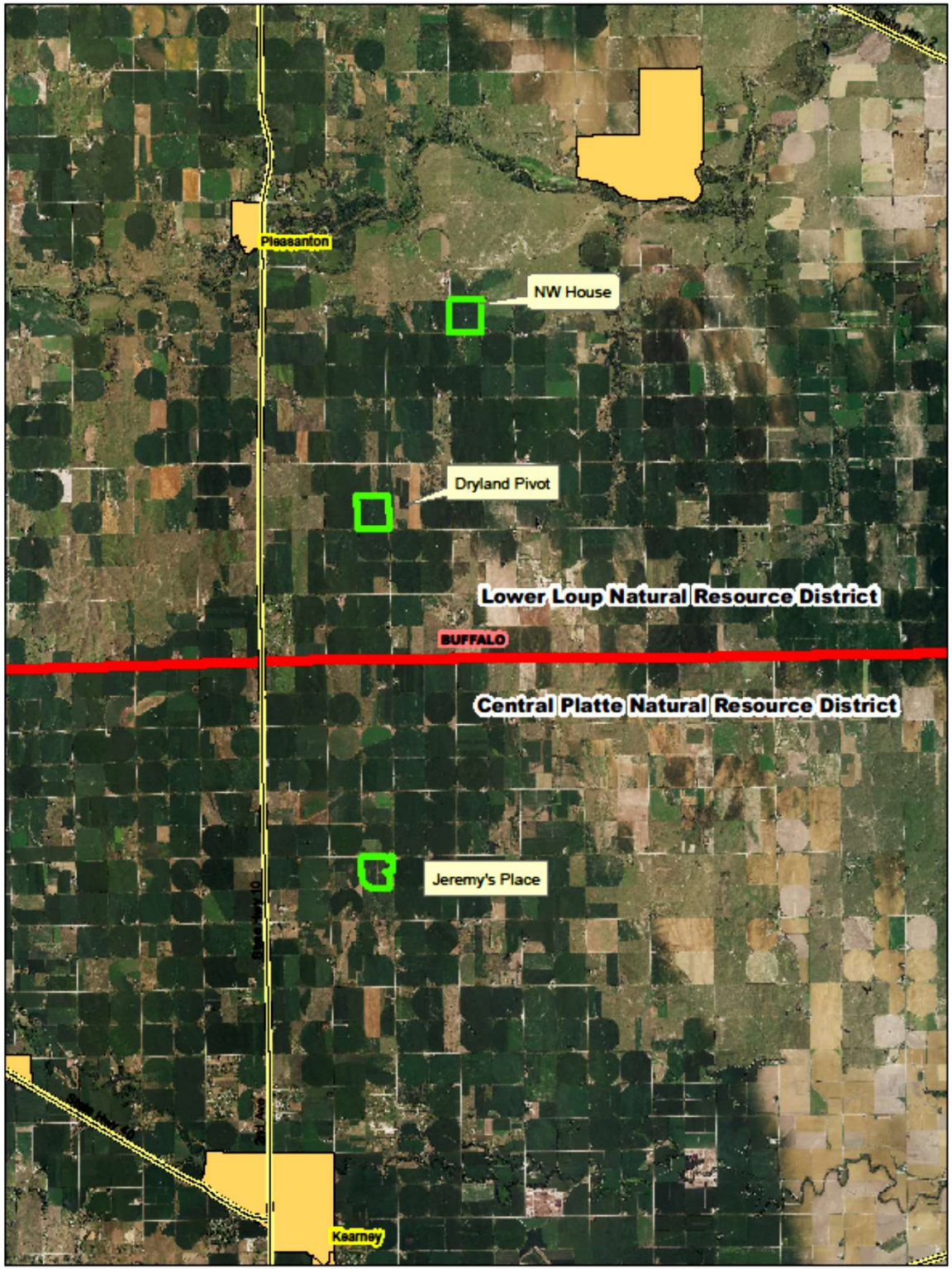
- ✓ Soil moisture/Potential groundwater recharge
- ✓ Movement of nitrate vertically through and below the root zone

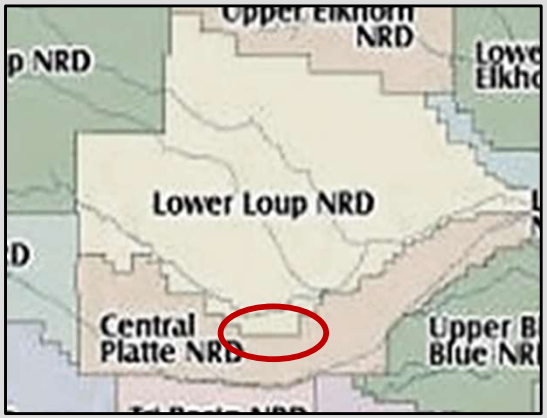
Project Overview

- **LLNRD and CPNRD partnership**
- **Funding via the Water Sustainability Fund**
- **Study effects of cover crop management practices**
  - Seasonal impacts on soil moisture and groundwater recharge
  - Secondary: Water quality (nitrate leaching)
- **Study Boundary**
  - Geographic region between the South Loup River and Wood River that has experienced groundwater declines.
- **POP:** August 2019 to June 2023
- **Growing Seasons:** 2020, 2021, 2022



Fields Selected





- **2 in LLNRD:**
  - NW of House
  - Dryland Pivot
- **1 in CPNRD:**
  - Jeremy's Place

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Field Design

LEGEND

- Base
- Node
- Cover Crop
- Study Field

0 200 400 Feet

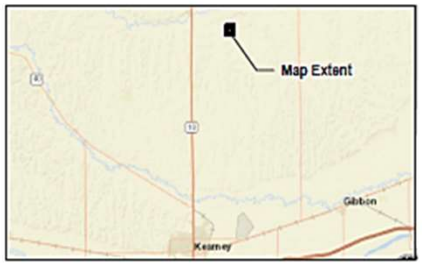

Figure 4 - Monitoring Equipment Layout - Northwest of House
Impact of Cover Crops on Soil Moisture and Nitrates
Annual Data Summary 2020
Lower Loup NRD and Central Platte NRD

EA Engineering, Science, and Technology, Inc., PBC

Field Layout

- 4 x Soil Moisture Node Sites
  - 2 nodes/site
  - 3 soil moisture sensors/node
- 1 x Base Station Node
- 1 x Rainfall Sensor Node

Cellular base station node, solar panel, and battery mounted at pivot

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Equipment

Data Collection & Monitoring Equipment

Irrometer (Irromesh) Components

Mfg./Part No.	Component
Irrometer 975NR	Relay Node
Irrometer 975B	Base
Irrometer 975G-BP	Cellular Gateway
Irrometer 200-SS-15	Watermark Sensor @ 3 per node
Irrometer 900RG	Rain Sensor
Irrometer 200TS	Temperature Sensor

Relay node mounted on end of PVC pipe "mast"

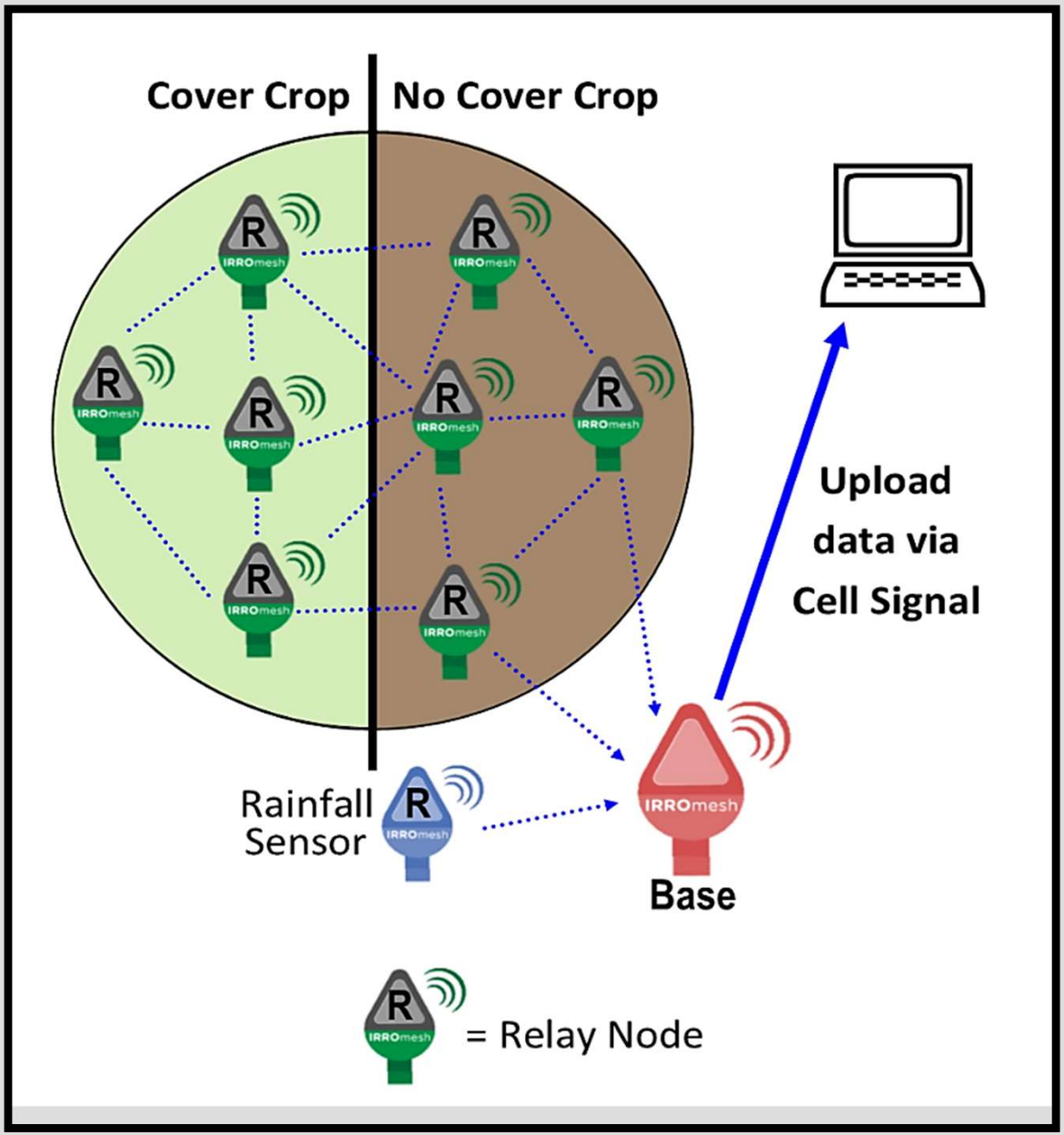
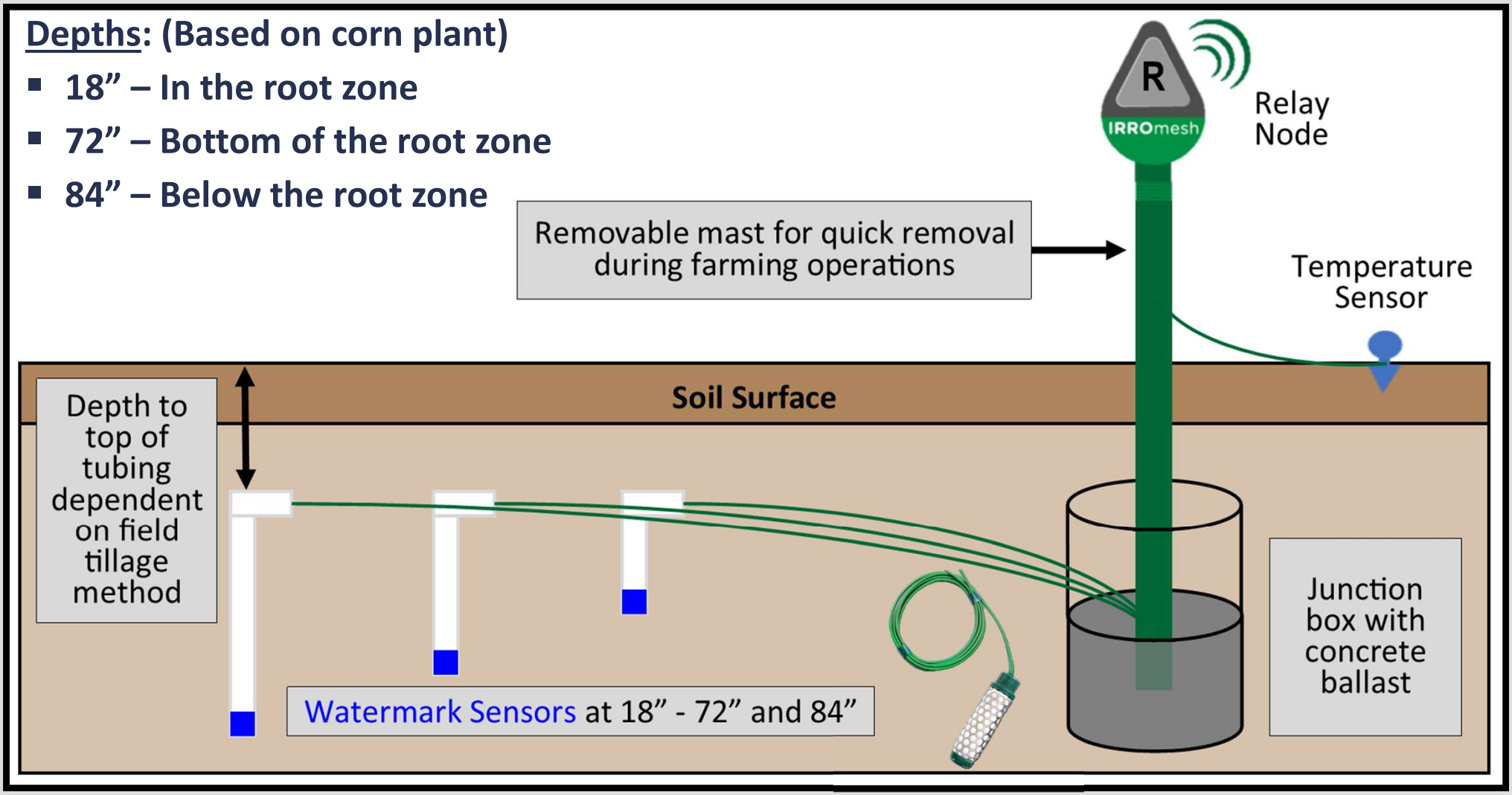


Diagram of Equipment Installation Layout

Depths: (Based on corn plant)

- **18” – In the root zone**
- **72” – Bottom of the root zone**
- **84” – Below the root zone**



Equipment Installation

- Initially installed in Nov 2019
- Removed/installed before and after harvest and planting each year (2019-2022)
- Final Removal in fall 2022
- Sensors deployed to depths of 18”, 72”, 84”
- EA + NRDs installed and removed

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Equipment Installation

Ground preparation for sensors and wiring

Equipment Installation

Buried sensors are wired to a relay node attached to a PVC mast to transfer signal

Equipment Installation and Removal

Installation and removal before and after planting and harvest

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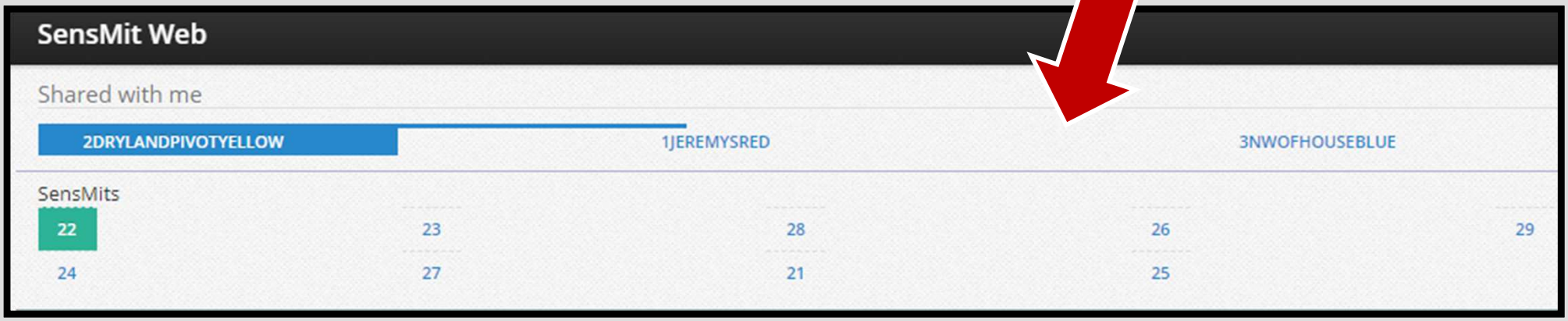
Equipment Maintenance & Adjustment

Did require some maintenance, adjustments, and modifications

Base Cellular Gate, Solar Panel, & Battery

SensMit Website – Data Collection Site



Data Calculations

- Data collected every 30 minutes
- Approximately 4 million data points
- Data cleaned and organized by seasons
- Used van Genuchten equation and unsaturated hydraulic conductivity formula to calculate potential recharge (inches/day)
- Differences in mean were considered significantly different when probability of drawing wrong conclusion was less than 10% , i.e., $p<0.1$

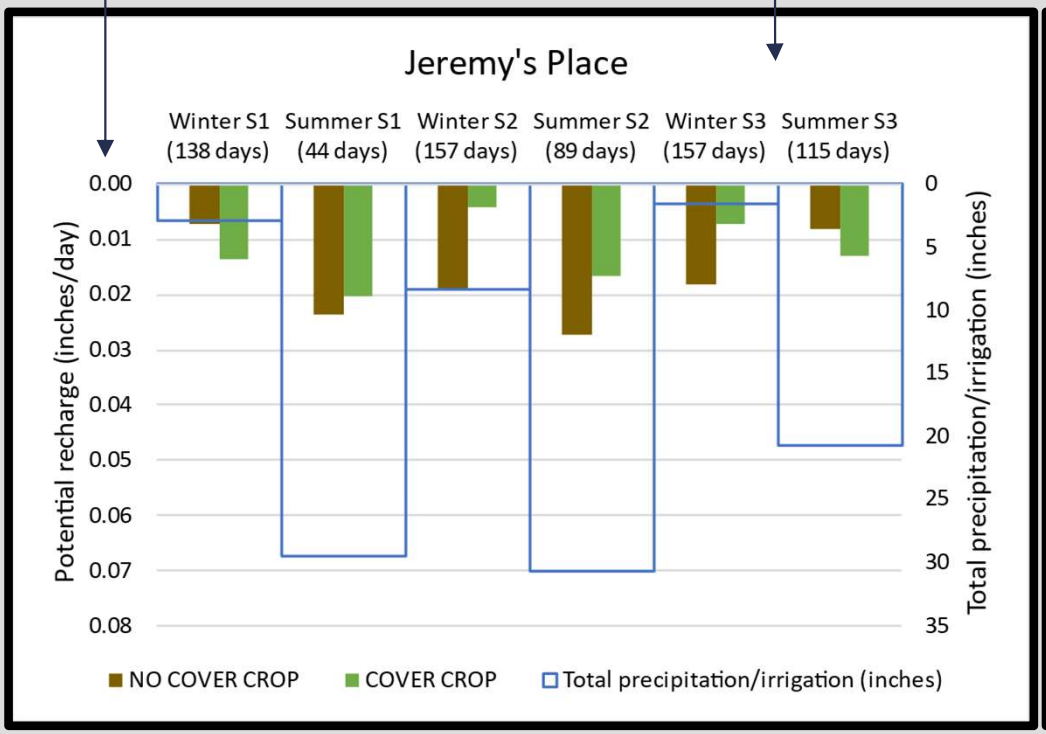
Season Name	Start Date	End Date
Winter S1	November 2019	April 2020
Summer S1	April 2020	September 2020
Winter S2	September 2020	April 2021
Summer S2	April 2021	October 2021
Winter S3	October 2021	April 2022
Summer S3	April 2022	October 2022

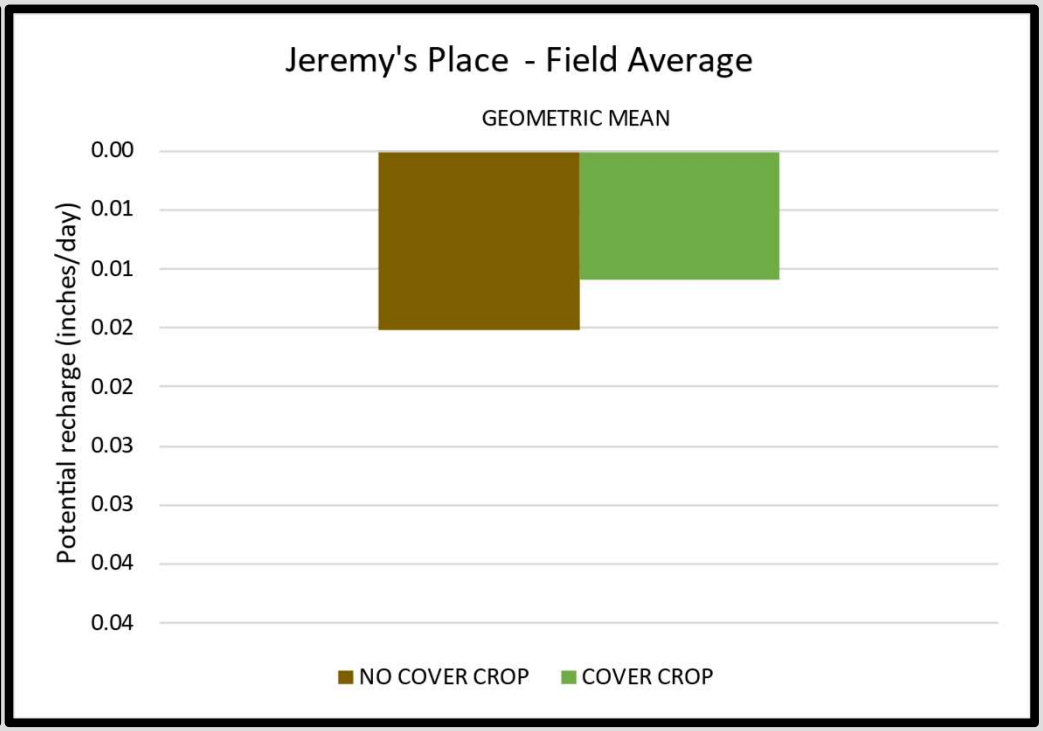
Notes:
S1 = Season in Year 1.
S2 = Season in Year 2.
S3 = Season in Year 3.

Results and Findings

Graph Interpretation

Timeline on X-axis
Potential recharge on Y-axis

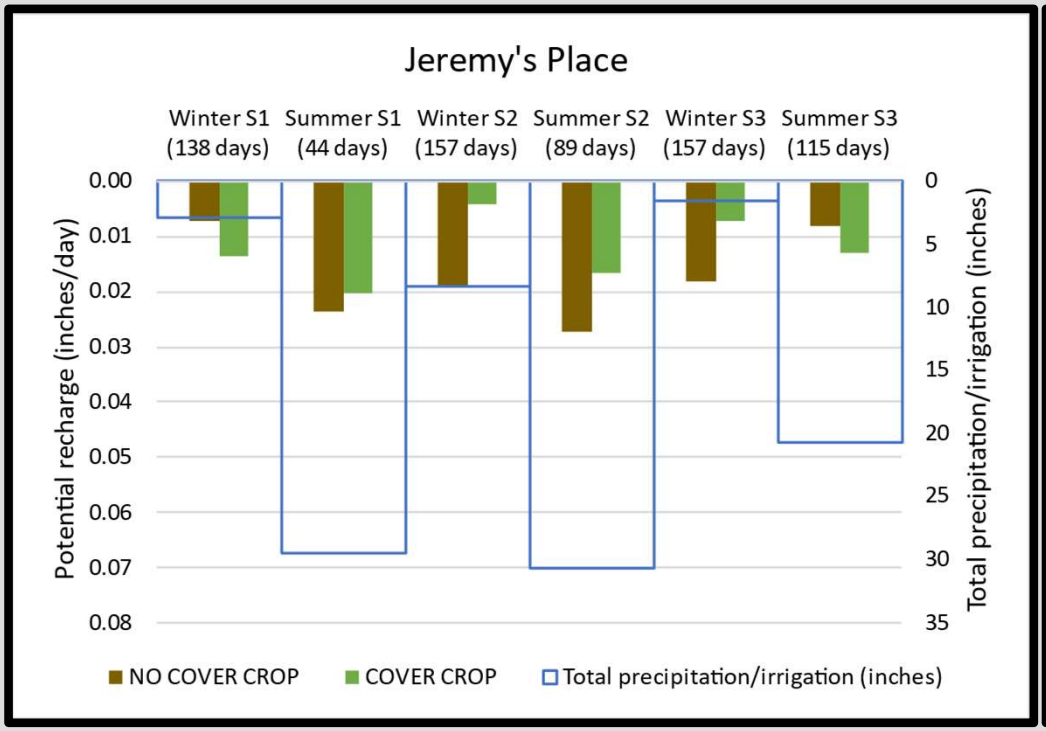


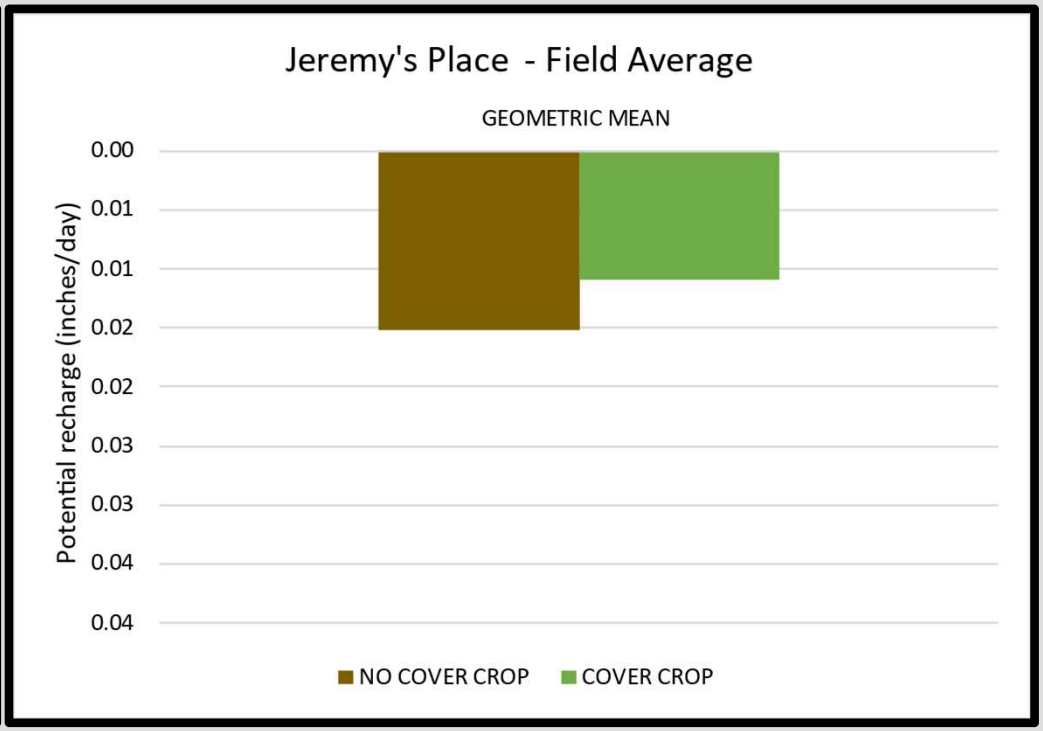


Brown bars = No Cover Crop
Green bars = Cover Crop
Blue bars = Precipitation/Irrigation

Data Results – Seasonal Potential Recharge

Jeremy's Place

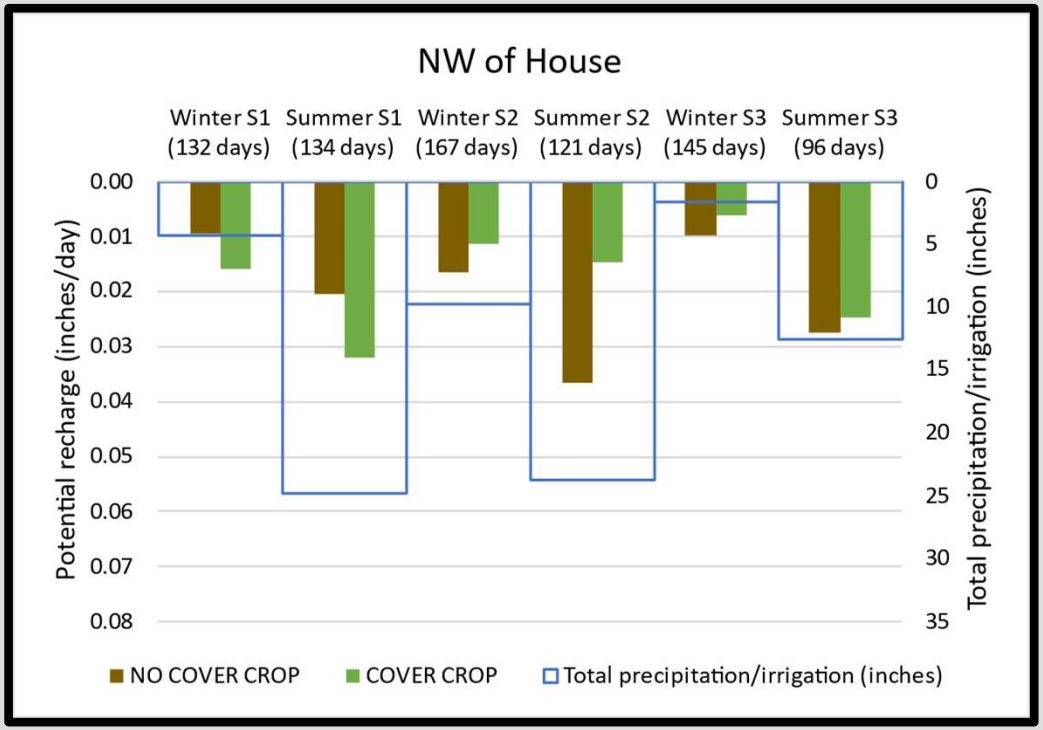


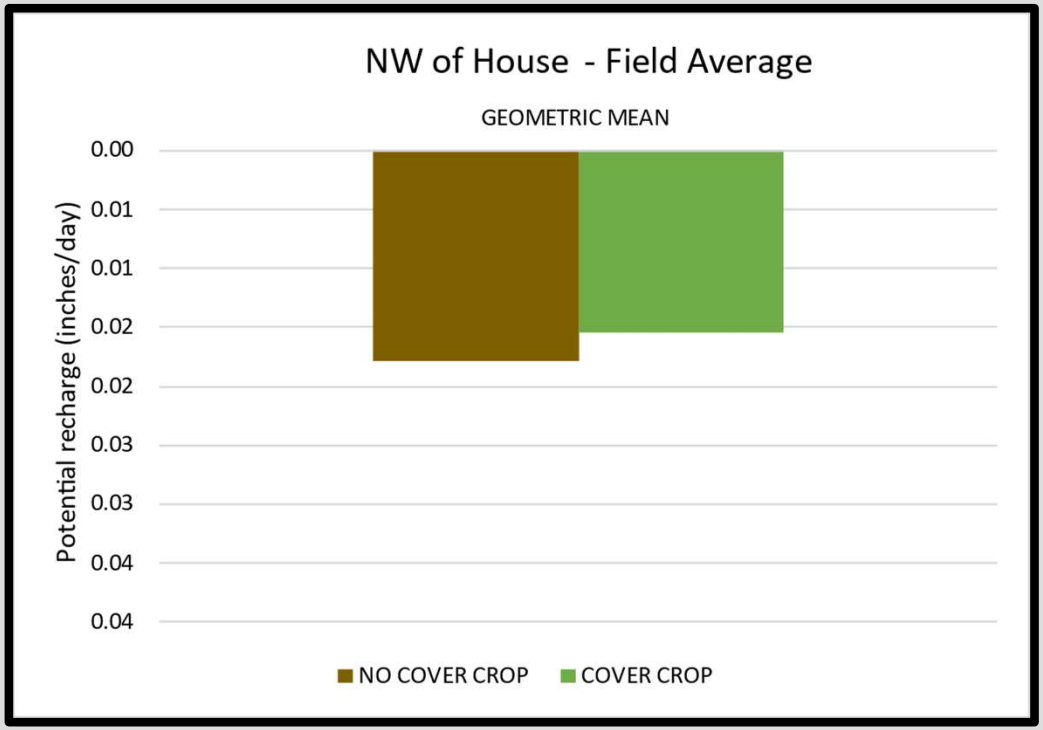


There is no statistical difference between Cover Crop and No Cover Crop at Jeremy's Place

Data Results – Seasonal Potential Recharge

NW of House

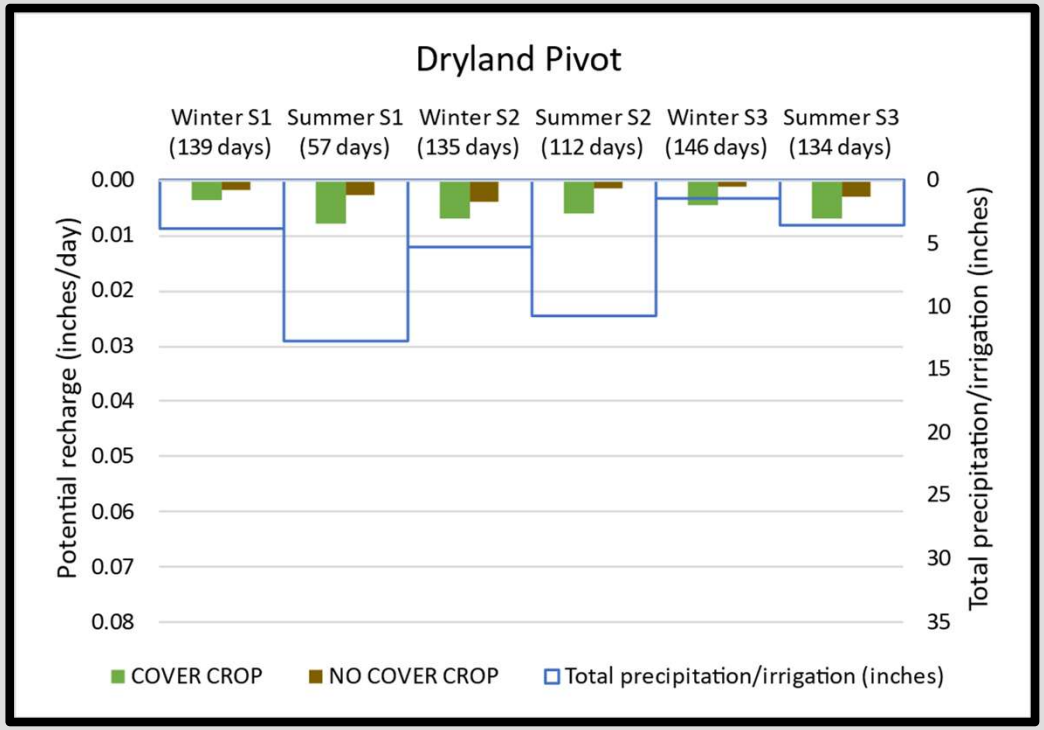


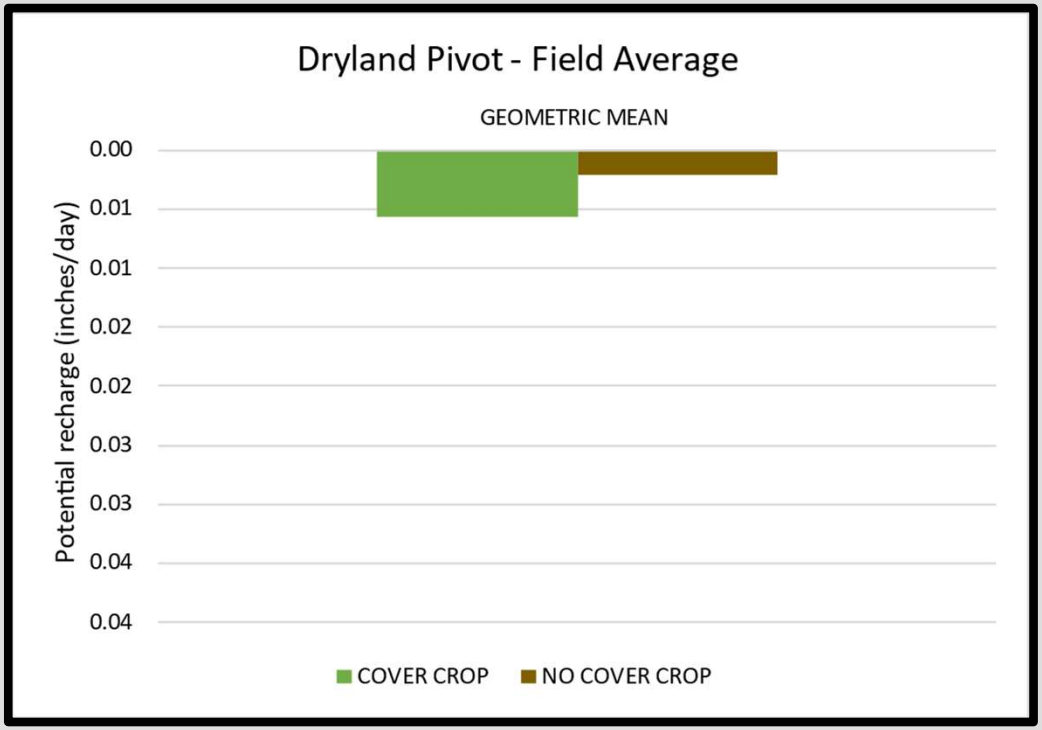


There is no statistical difference between Cover Crop and No Cover Crop at NW of House

Data Results – Seasonal Potential Recharge

Dryland Pivot

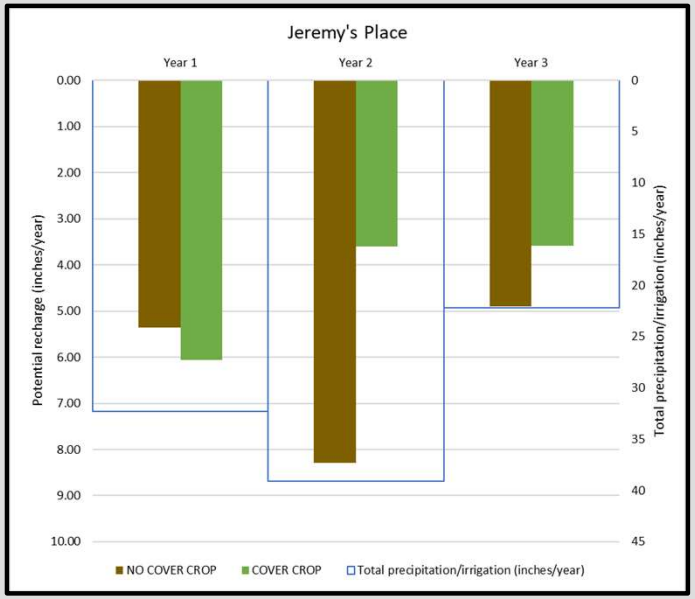




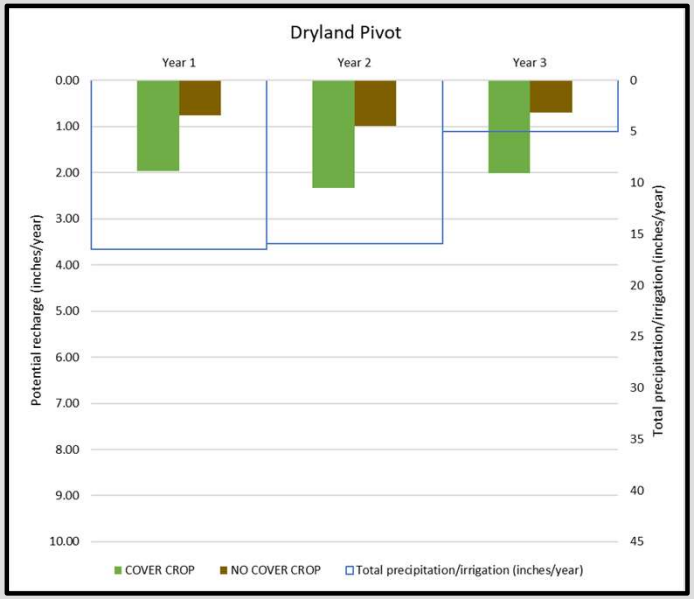
There is a statistical difference between Cover Crop and No Cover Crop at Dryland Pivot

Data Results – Annual Potential Recharge

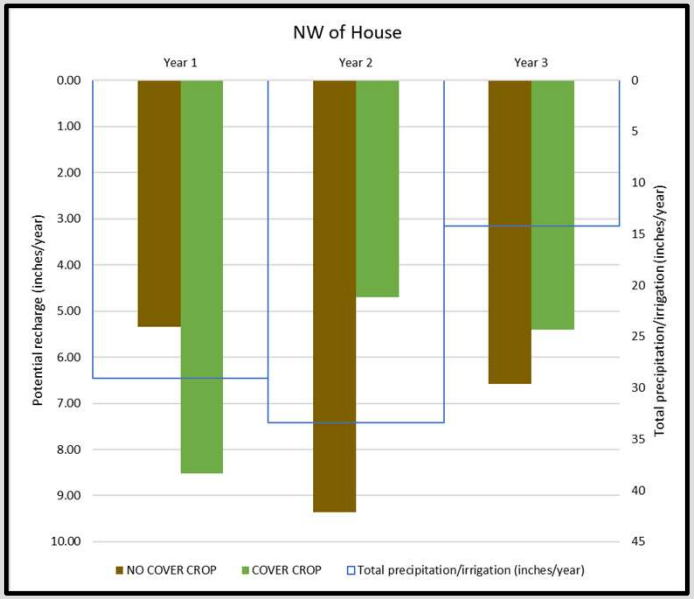
Cover Crop vs No Cover Crop



There is no statistical difference between Cover Crop and No Cover Crop at Jeremy's Place



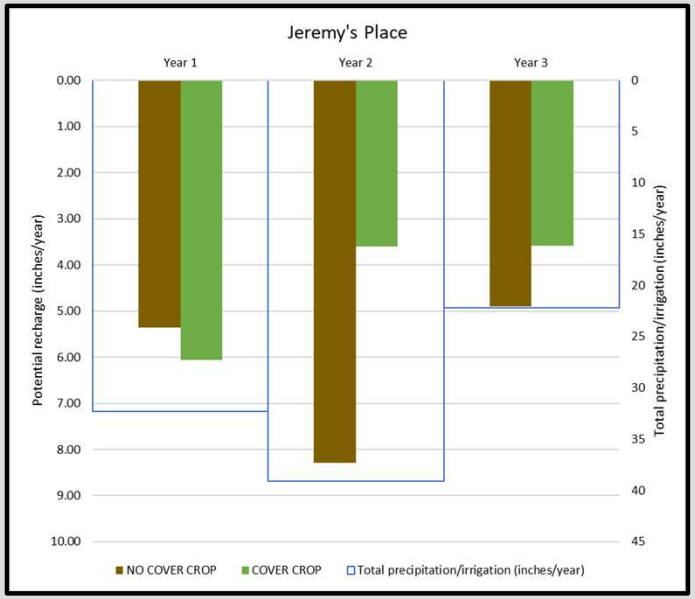
There is a statistical difference between Cover Crop and No Cover Crop at Dryland Pivot



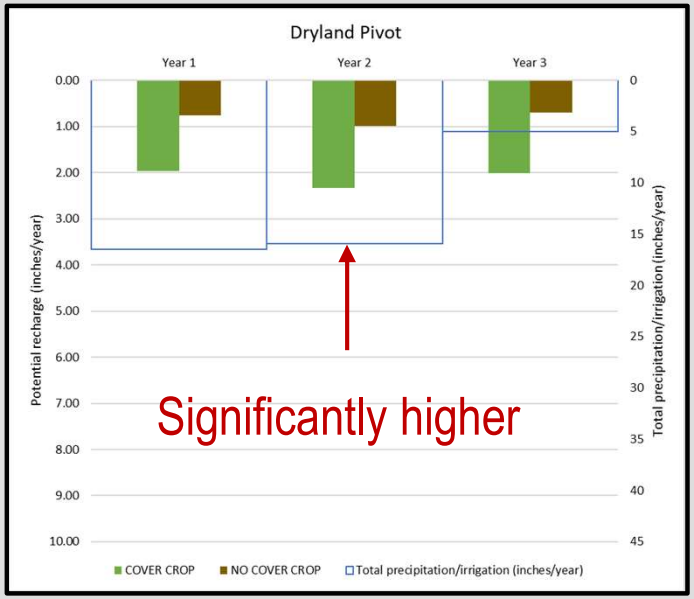
There is no statistical difference between Cover Crop and No Cover Crop at NW of House

Data Results – Annual Potential Recharge

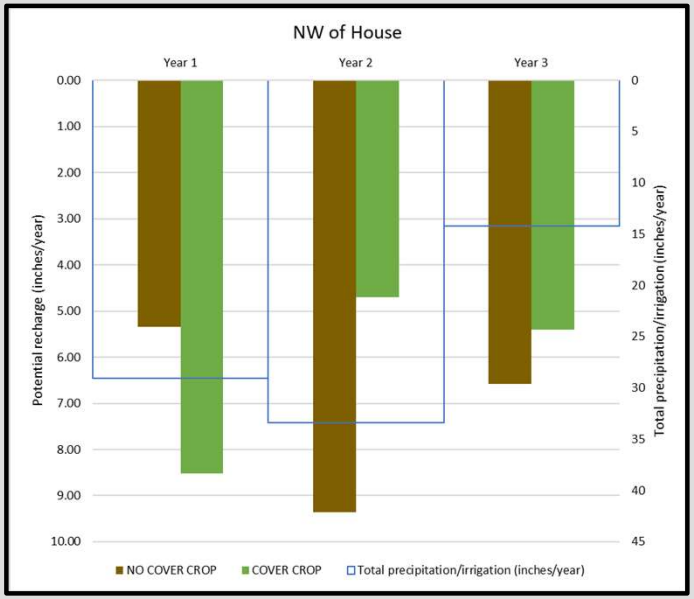
Individual Years



There is no statistical difference between the 3 years



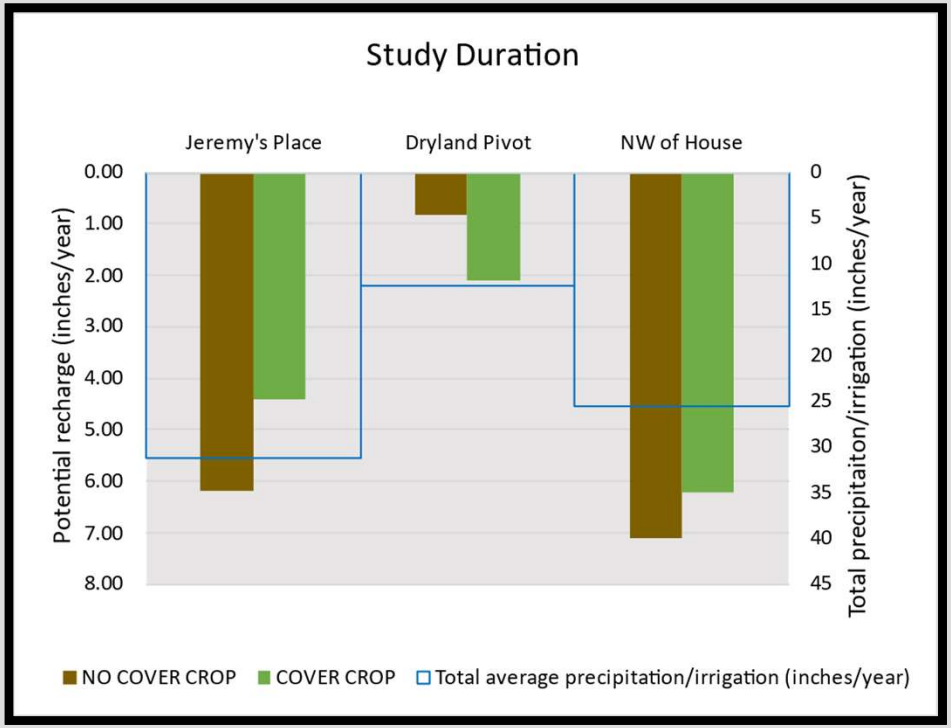
There is a statistical difference between the 3 years

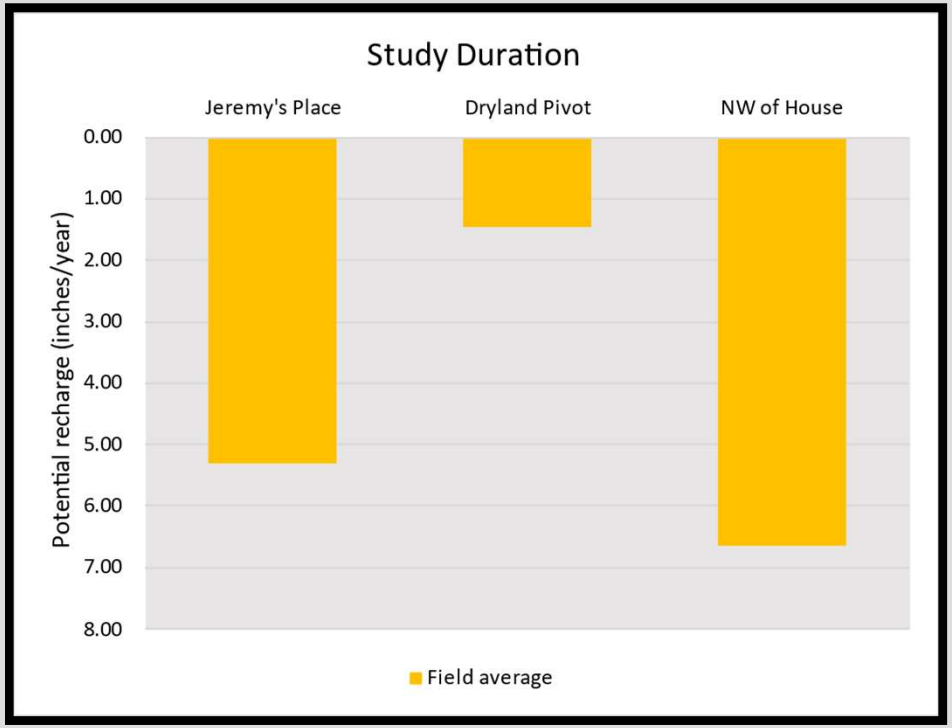


There is no statistical difference between the 3 years

Data Results – Project Duration Potential Recharge

All Years Combined by Field

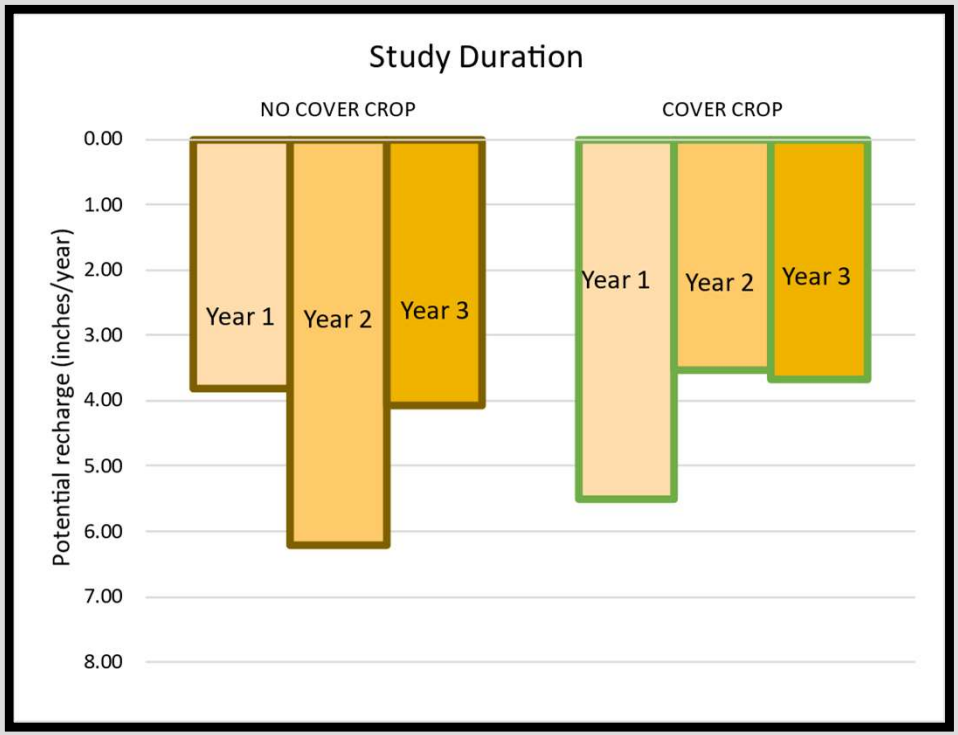


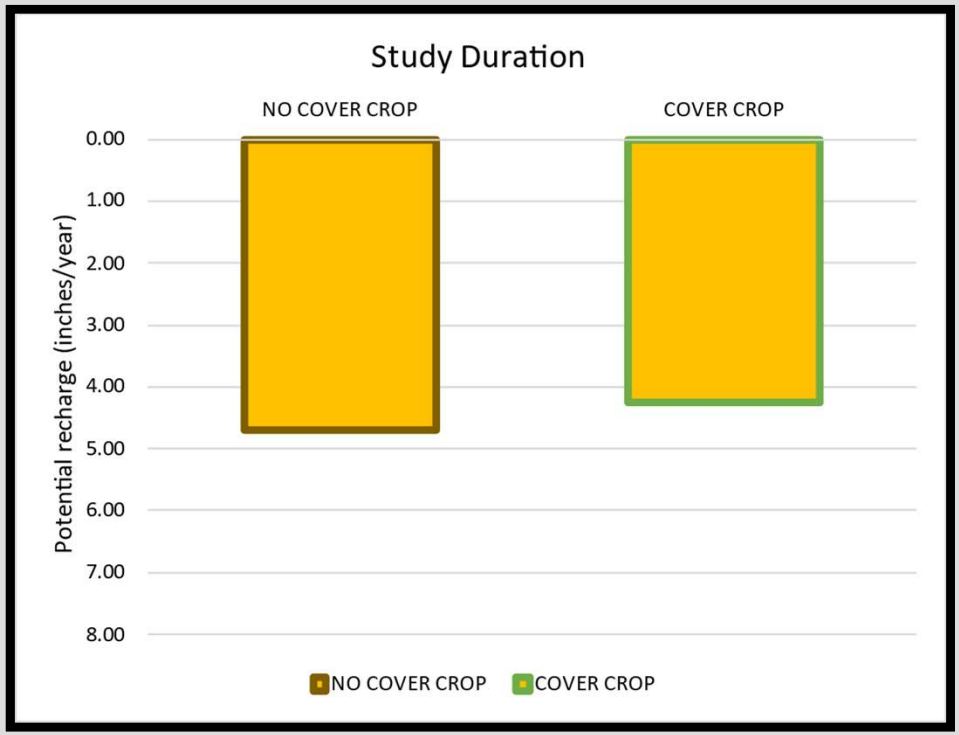


There is a statistical difference between the fields where Dryland Pivot has significantly lower potential recharge compared to the other two fields

Data Results – Project Duration Potential Recharge

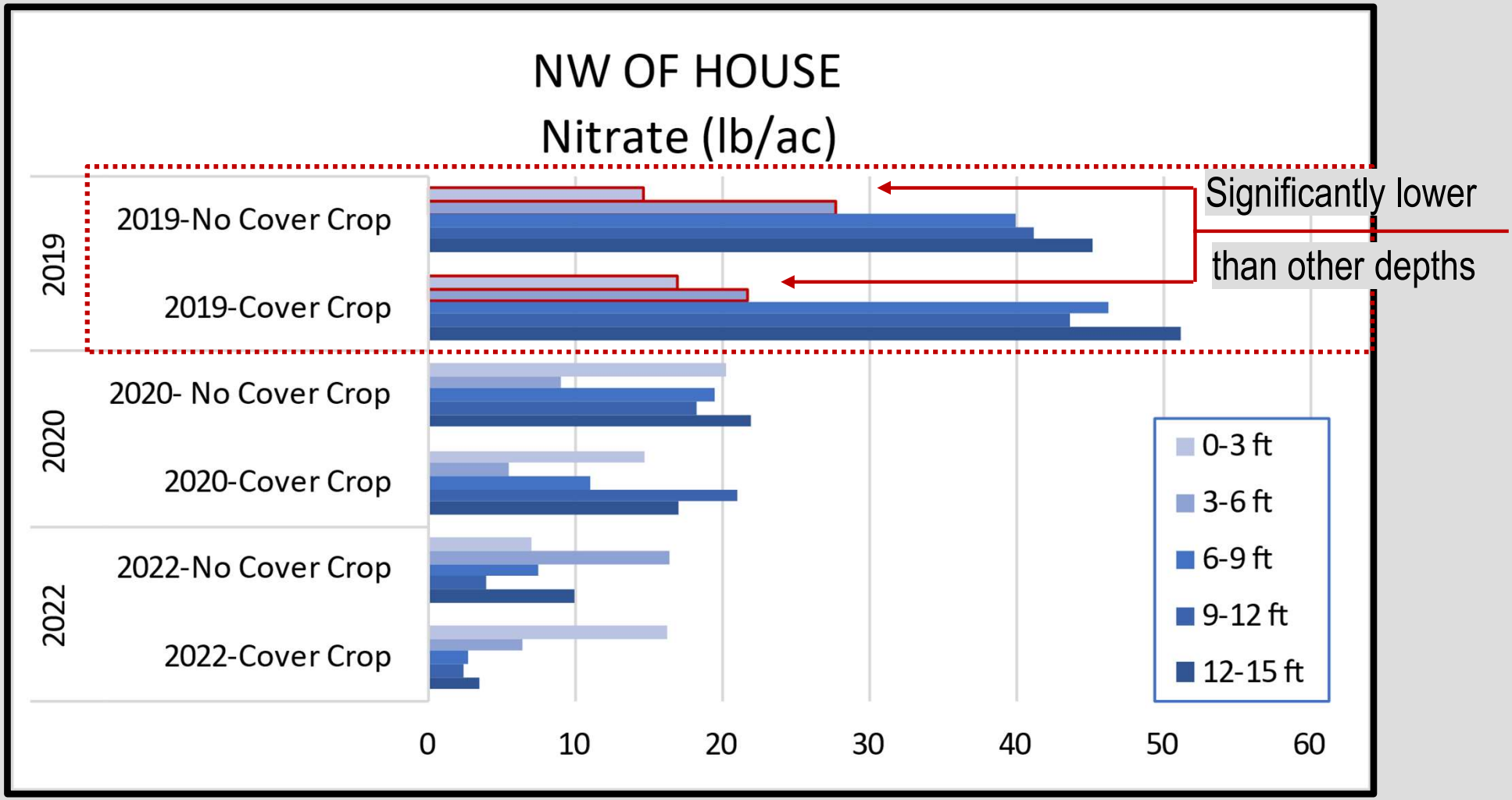
All Fields Combined





There is no statistical difference between Cover Crop and No Cover Crop

Data Results – NW of House Soil Nitrate



There is a statistical difference between depths in 2019

Challenges & Lessons Learned

- **Complex Systems**
- **Variable Management Practices**
  - Crops
  - Tillage
  - Irrigation
  - Nutrient application
- **Schedules**:
  - Coordination
  - Field operations, planting, harvest, etc.
- **Weather impacts**
- **Equipment:**
  - Set-up, operation and maintenance, installation, and removal
  - Adjustments and work arounds
  - Technology requirements and limitations
  - Replacement / cost
- **Requires considerable hands-on field work**
- **Data:**
  - Study design
  - Collection
  - Lots of data
  - Variability
  - Interpretation

Thank you!

Questions?

Jason Moudry

Water Programs Specialist, Lower Loup NRD

Dan Bigbee

Sr. Environmental Scientist, EA

April 16, 2024

Cover Crop Impact Study

Prepared for:

Nebraska Groundwater Monitoring Council

Prepared by:

CPNRD CENTRAL PLATTE NATURAL RESOURCES DISTRICT

LOWER LOUP NATURAL RESOURCES DISTRICT

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