# Project Summary

# Leaf Area Index Estimates to Inform Midrotation Treatments

Co-PIs: Rachel L. Cook, NCSU (lead), Aaron Weiskittel, UMaine, Mark Kimsey, U Idaho, Alicia Peduzzi, UGA
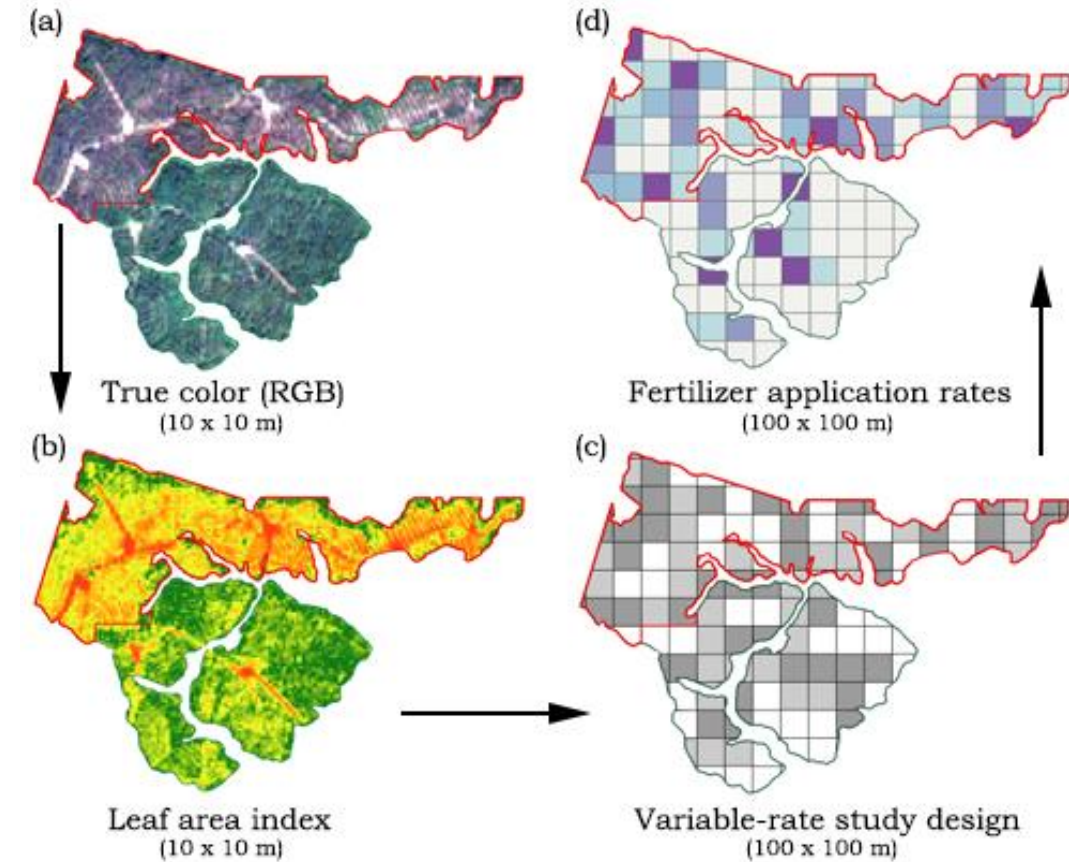Project Code CAFS.21.87

June 2025

# Research Plan

- Use LAI model to develop potential productivity and response maps in conjunction with soils and climate data (Continued)

- Apply LAI tools to Midrotation silvicultural decisions

- Assess operational level response to herbicide and/or variable rate fertilization

- Use canopy LAI to make Fertilizer Rate decisions (vs Random rate)

- Assess response in canopy LAI due to changes in understory LAI

- Use repeat LiDAR flights (and ground truth data) to assess individual tree height and volume response to treatments

# Experimental Design

- Herbicide vs No Herbicide

- + Random application N (lb) +
  10% P
  - 100
  - 200
  - 300

- OR: LAI-based rates of
  elemental N (lb/ac) + 10%
  elemental P

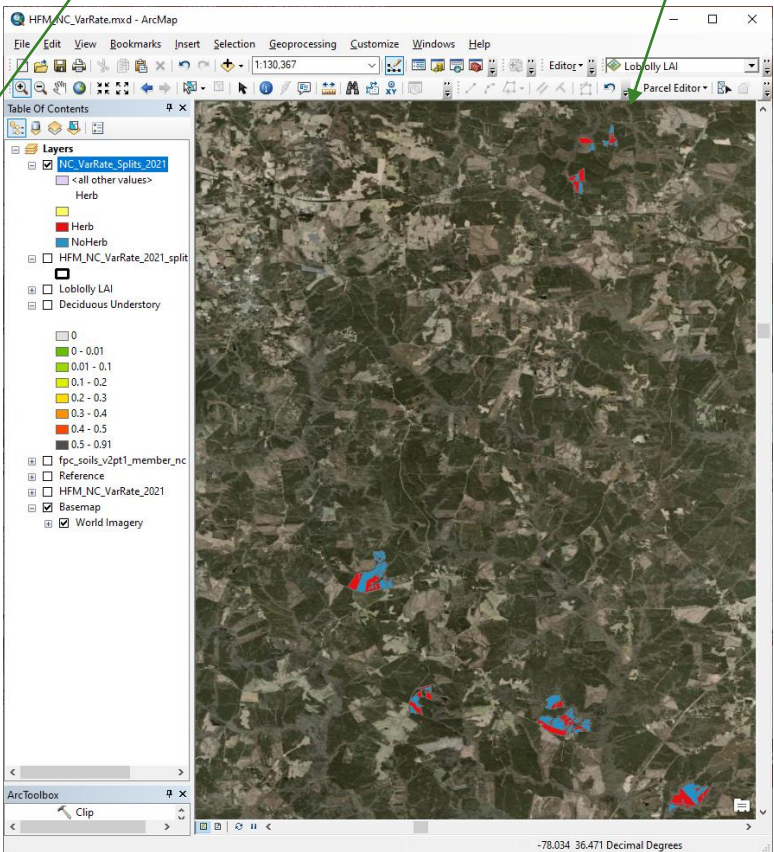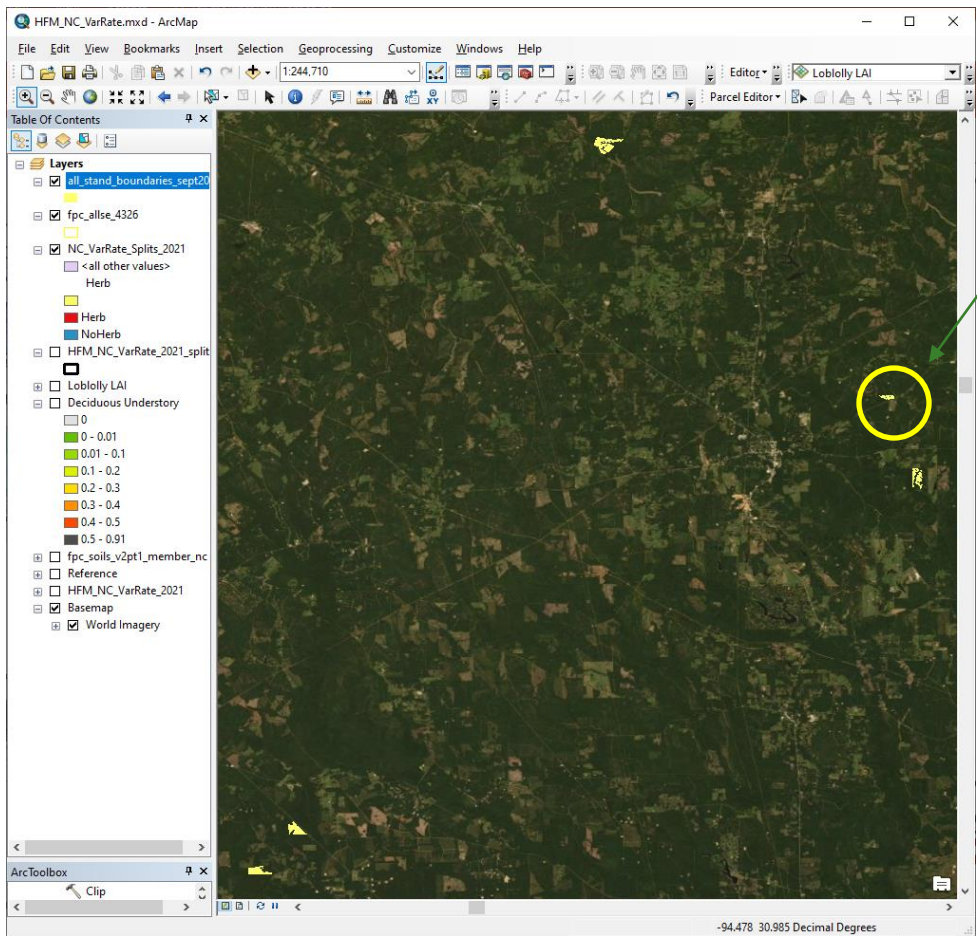| LAI | N Rate lb/ac |
|---|---|
| >3.5 | 0 |
| 3.0-3.5 | 100 |
| 2.5-3.0 | 150 |
| 2.0-2.5 | 200 |
| 1.5-2.0 | 250 |
| 1.0-1.5 | 300 |



(a) True color (RGB) (10 x 10 m)

(b) Leaf area index (10 x 10 m)

(d) Fertilizer application rates (100 x 100 m)

(c) Variable-rate study design (100 x 100 m)

Treatments based on 1 ha grid

# Study Locations

630 acres

1500 acres

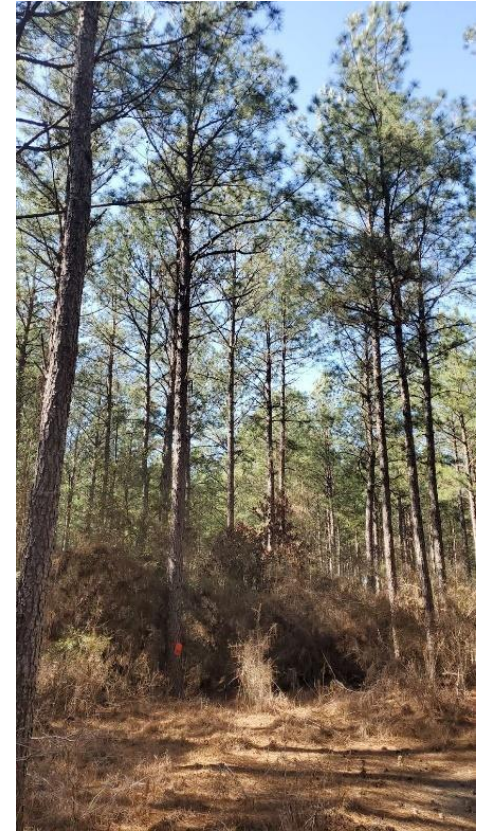# Treatments



Control



Fert

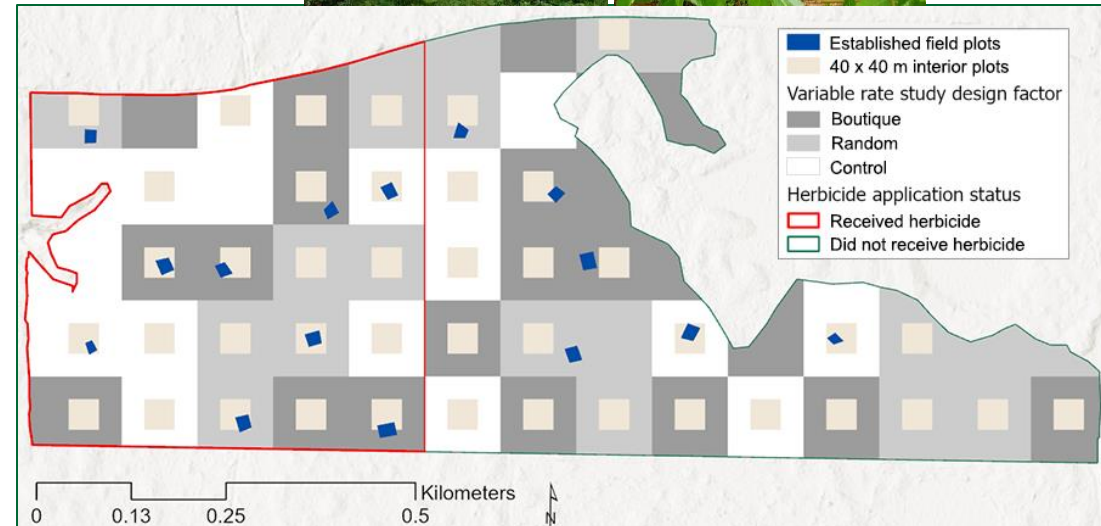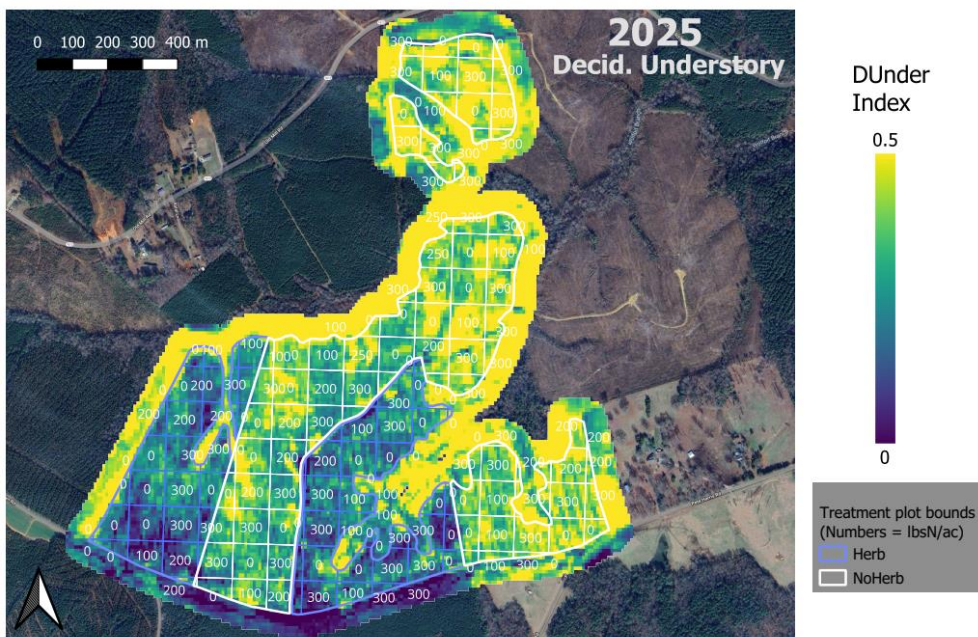

Herb



Fert + Herb

# Field data collection

## Measurements taken:

- Diameter

- Height

- Height to live crown

- Understory metrics

  - total percentage of ground cover occupied by understory with living foliage

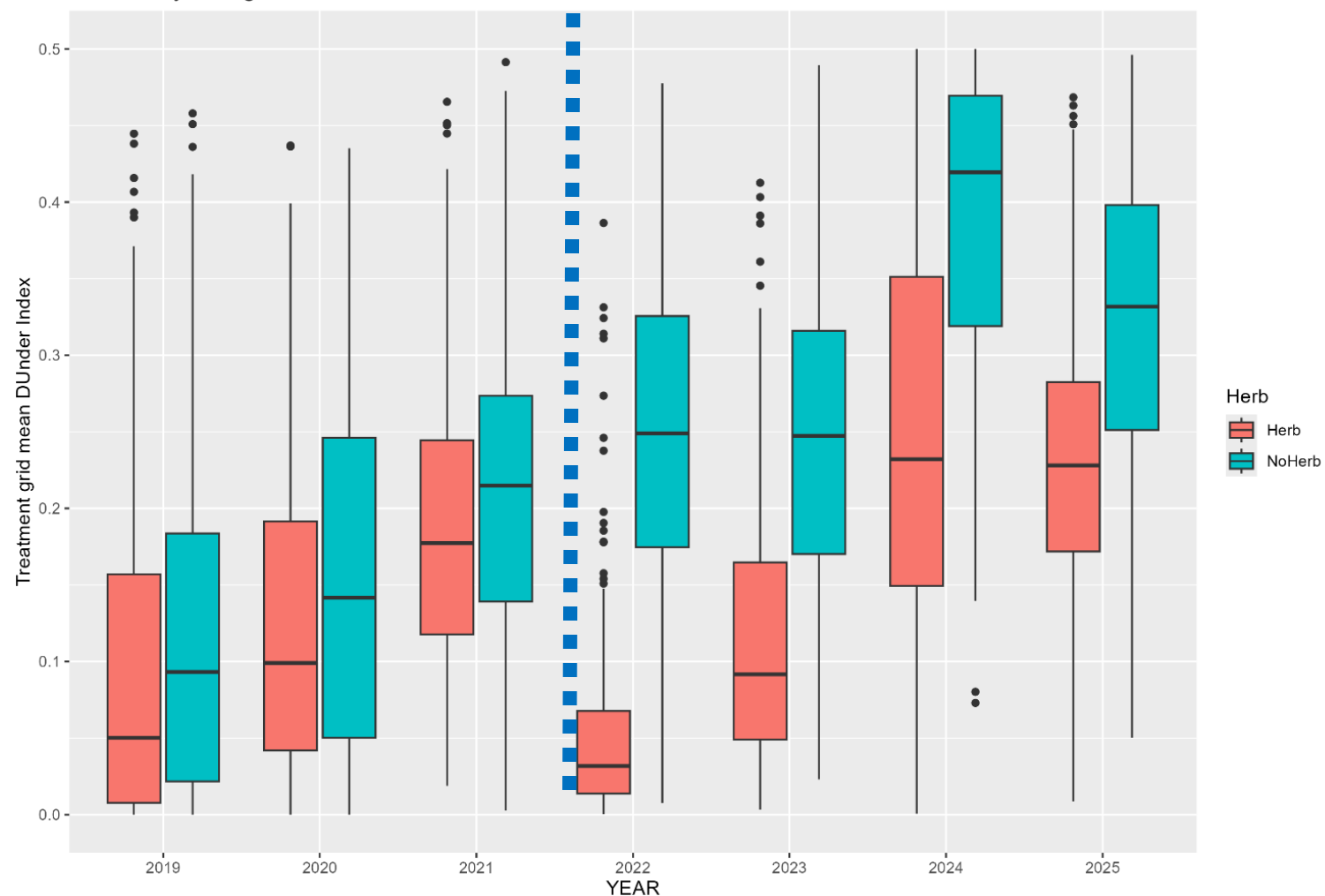  - fraction evergreen and/or deciduous

  - max & mean heights

# NC Variable Rate Understory LAI
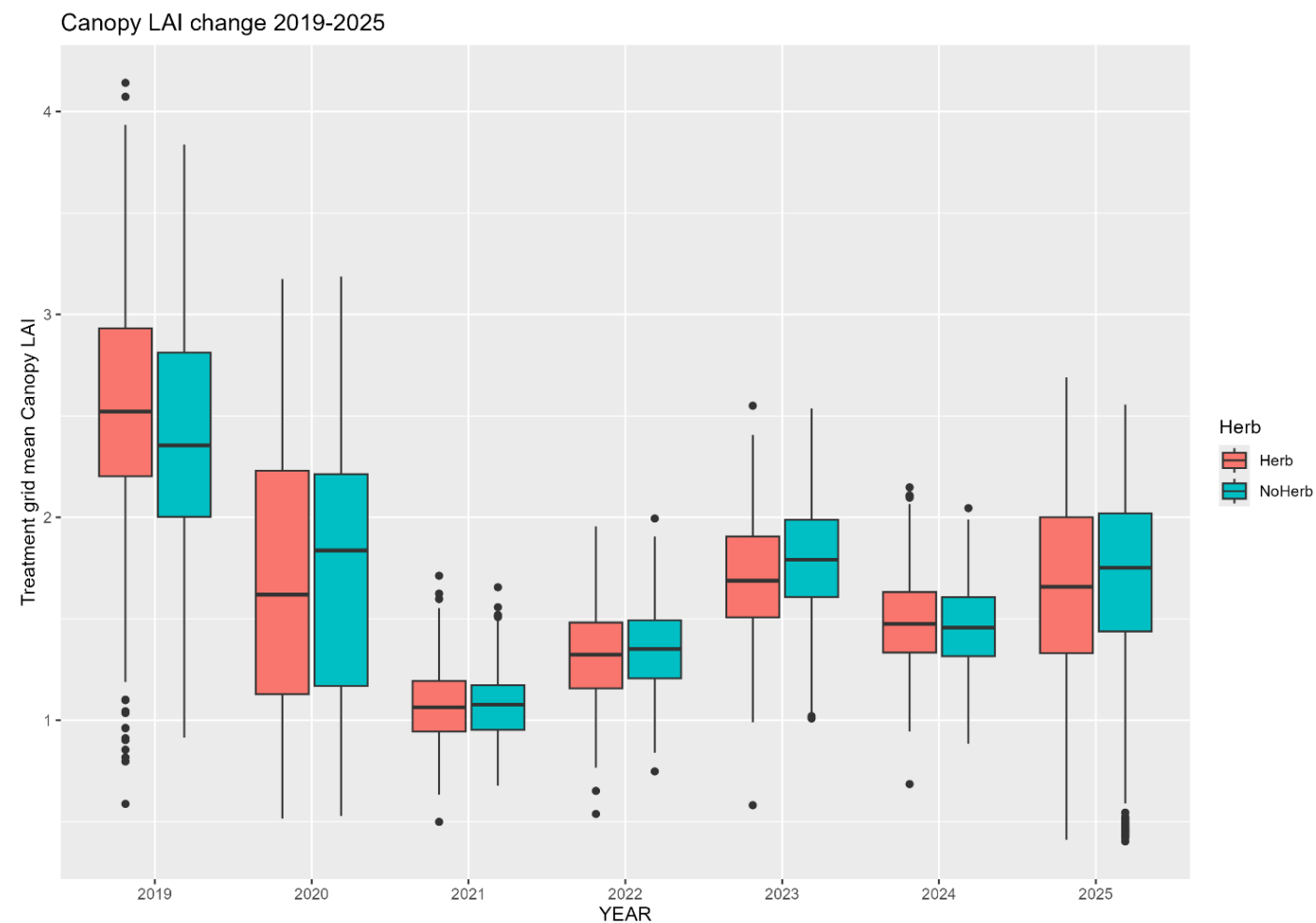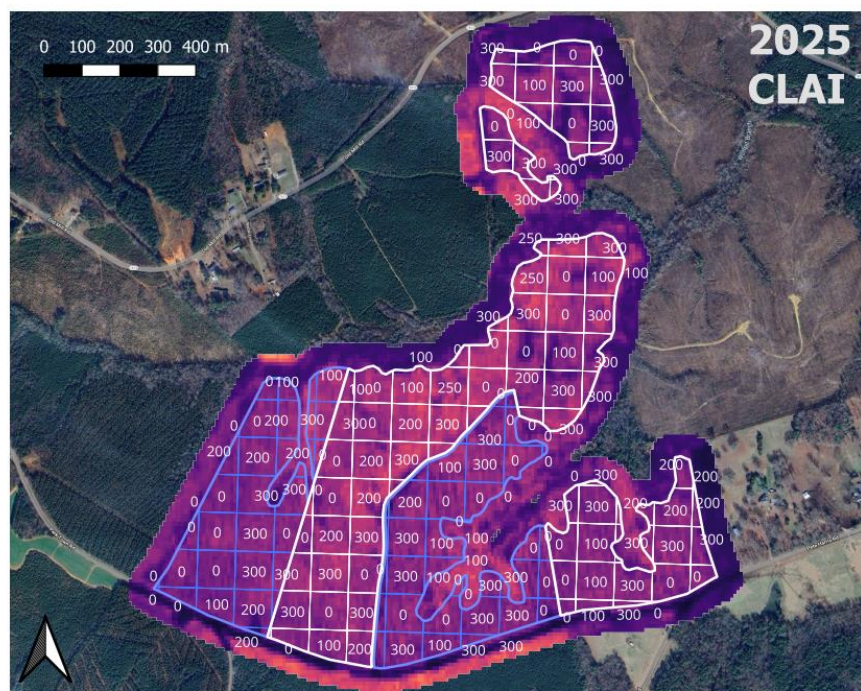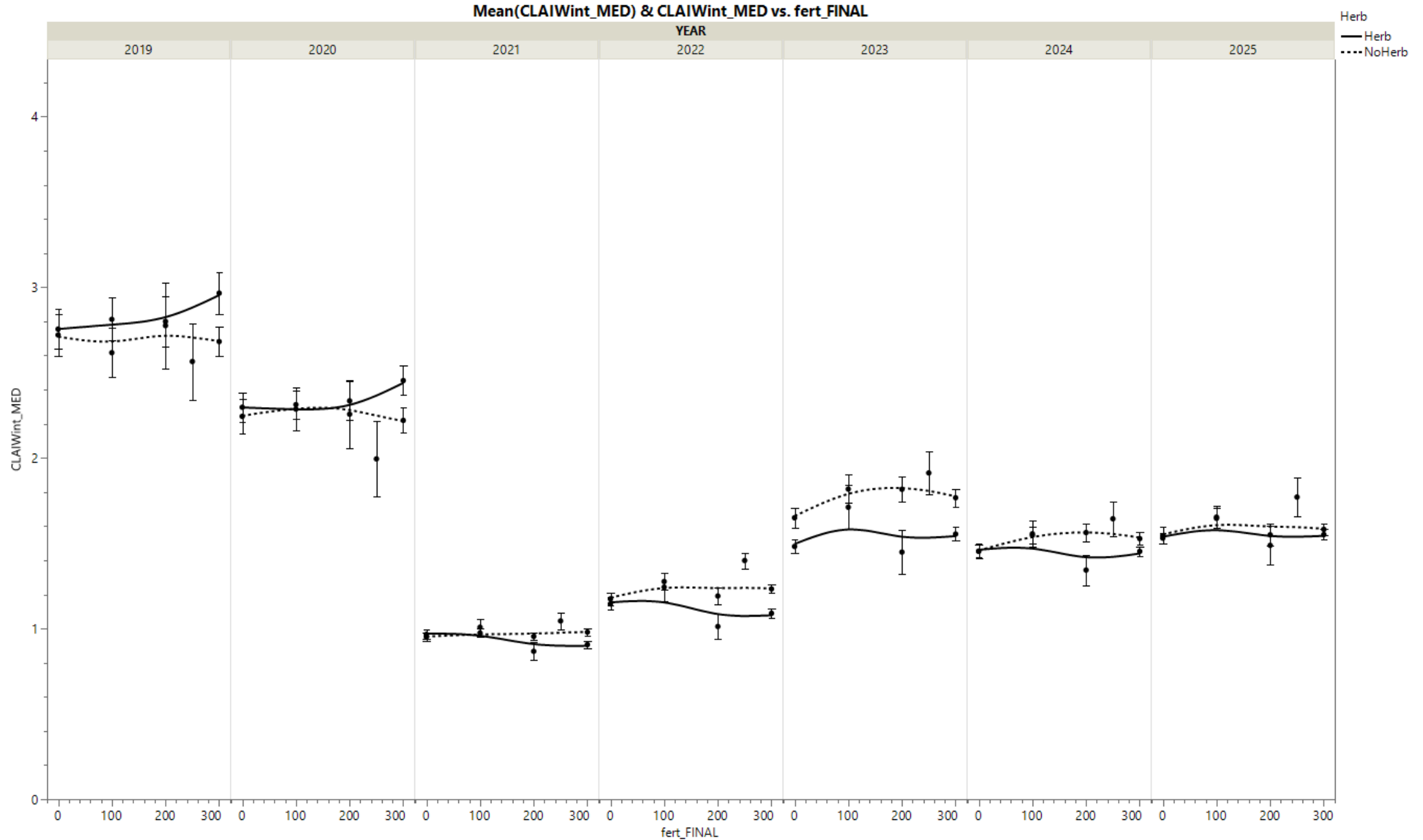


Understory change 2019-2025
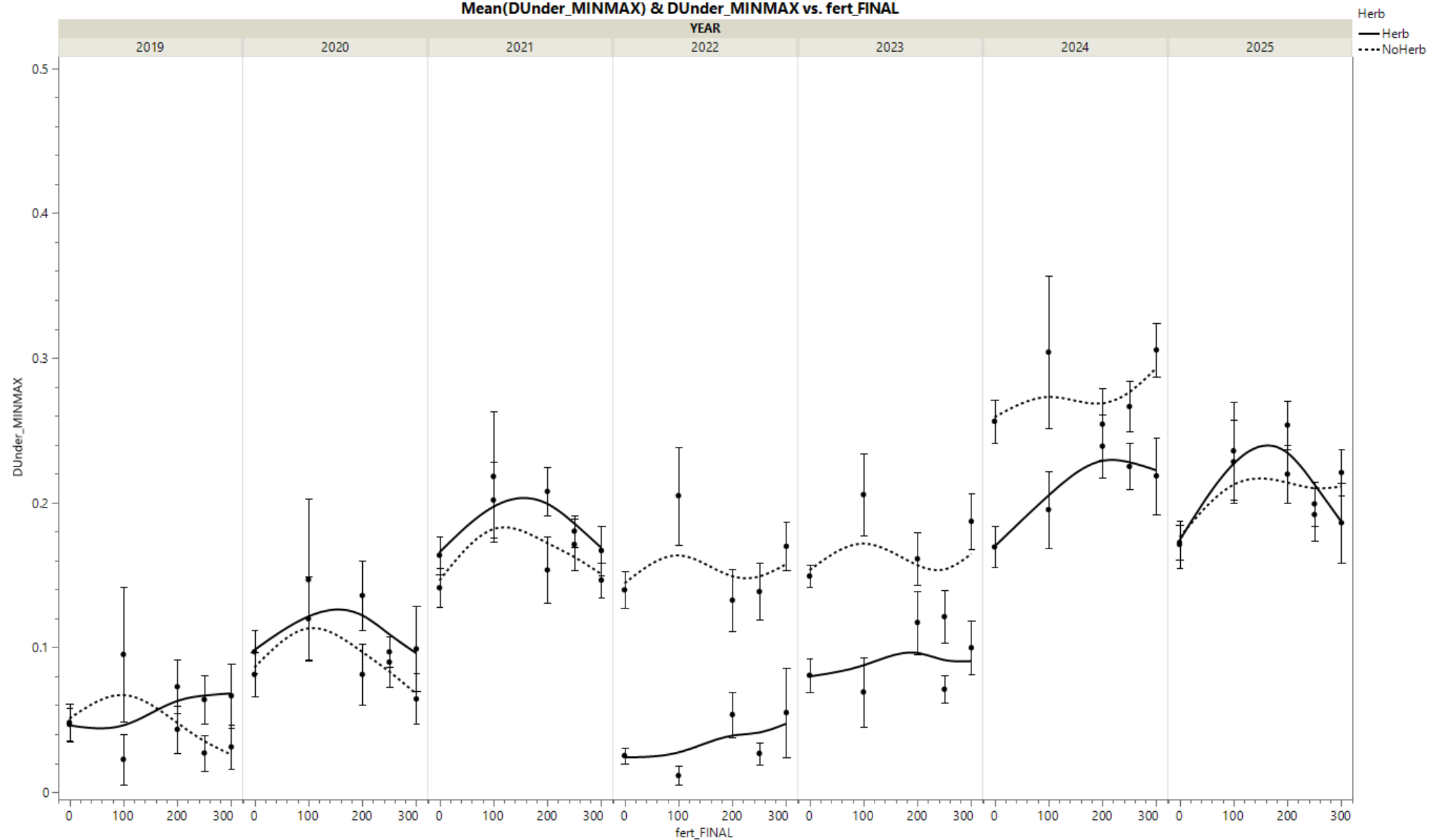
**Herb Sept 21**

Clear drop in deciduous understory
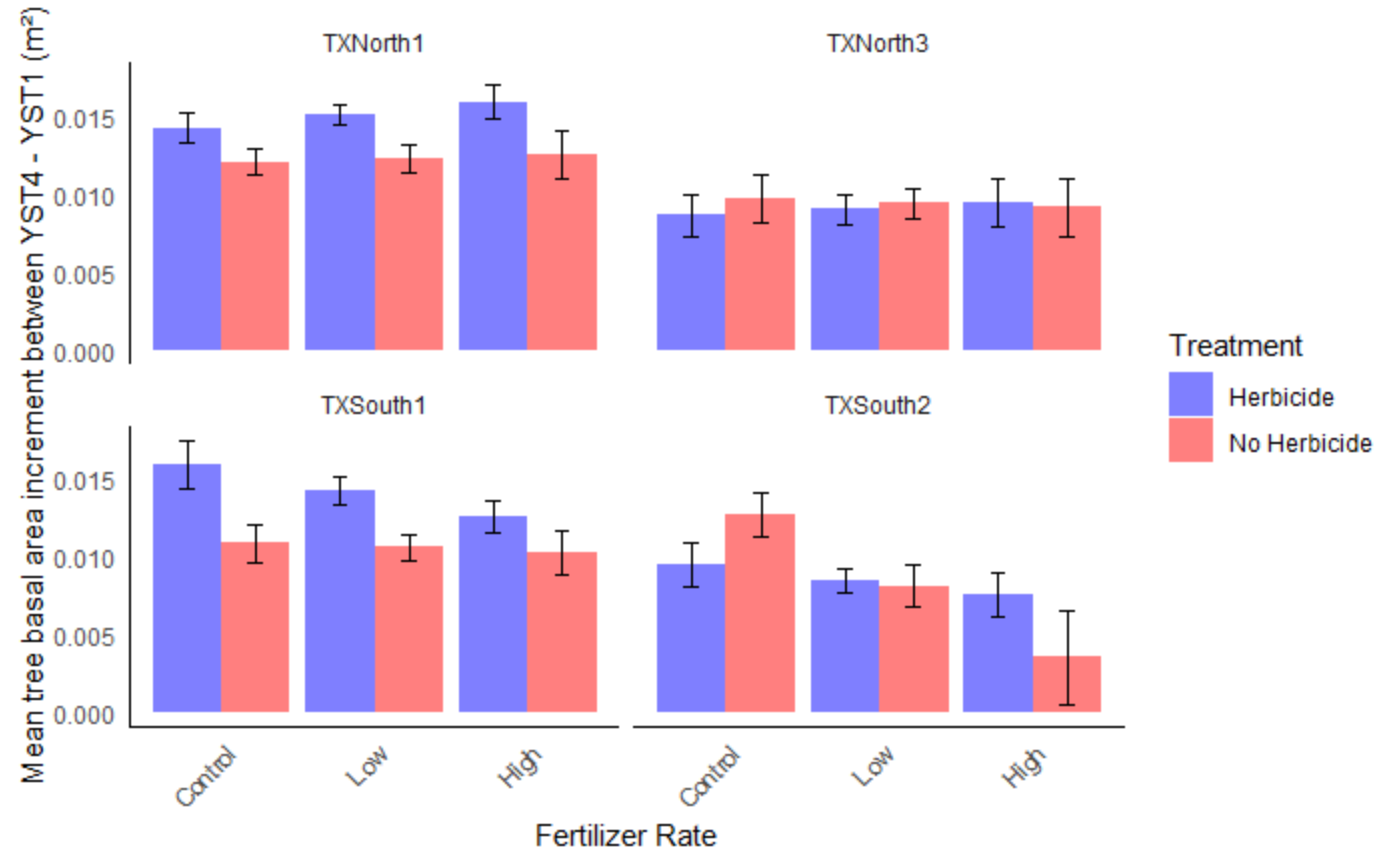
# NC Variable Rate Canopy LAI



Canopy LAI change 2019-2025

# Winter Canopy LAI: Fert application x Herbicide



Mean(CLAIWint_MED) & CLAIWint_MED vs. fert_FINAL

# Stand B: Deciduous Understory: Fert application x Herbicide



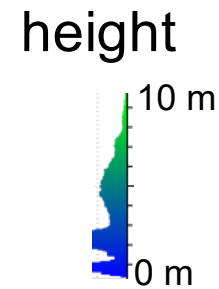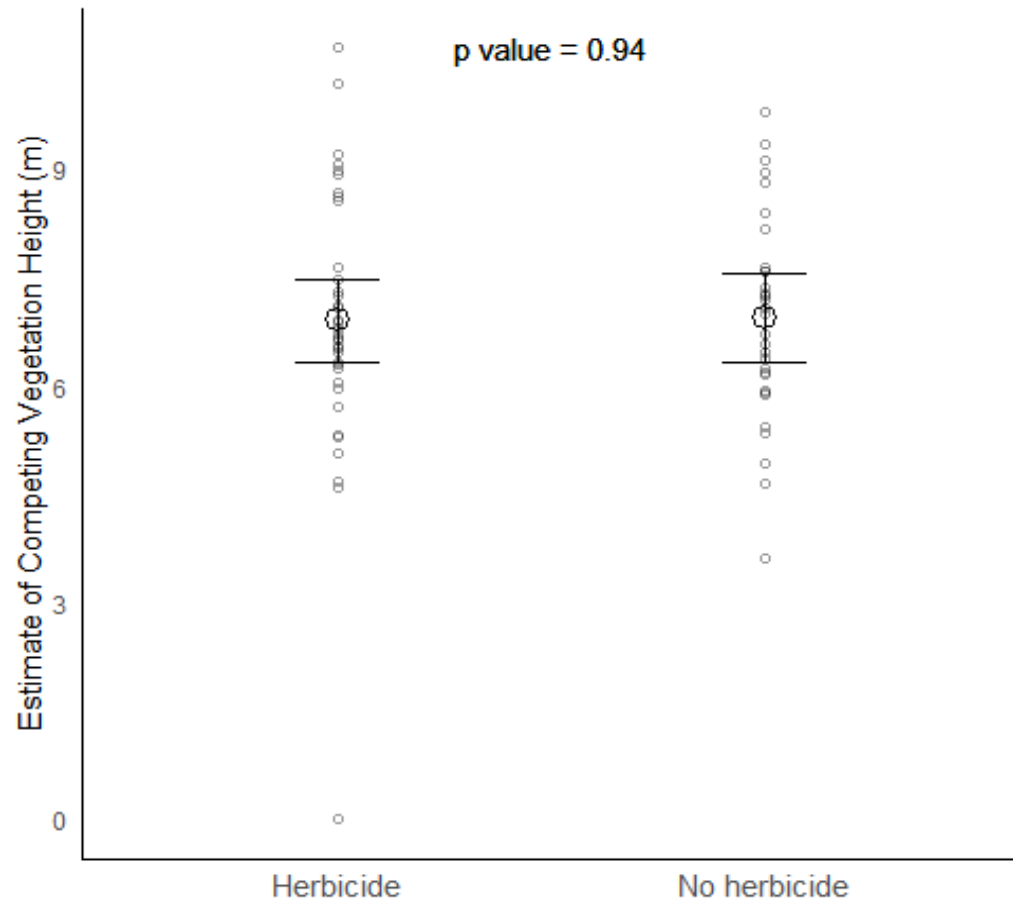Mean(DUnder_MINMAX) & DUnder_MINMAX vs. fert_FINAL
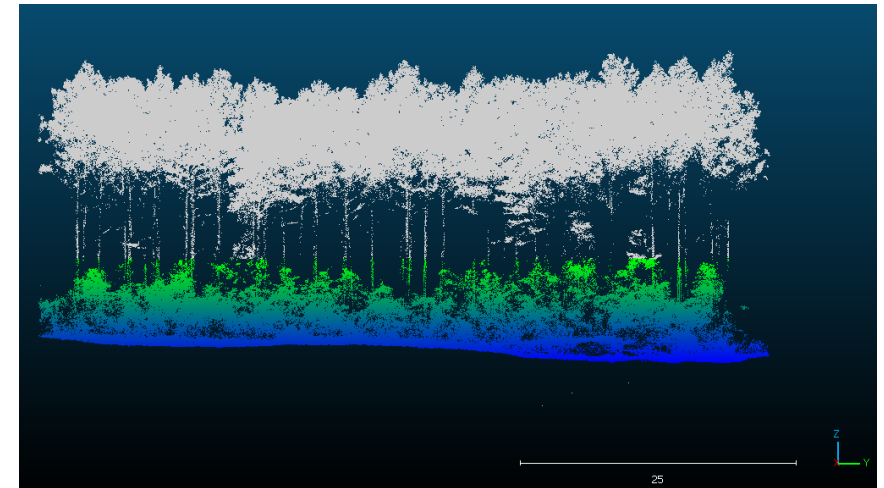
# TX Variable Fert x Herb
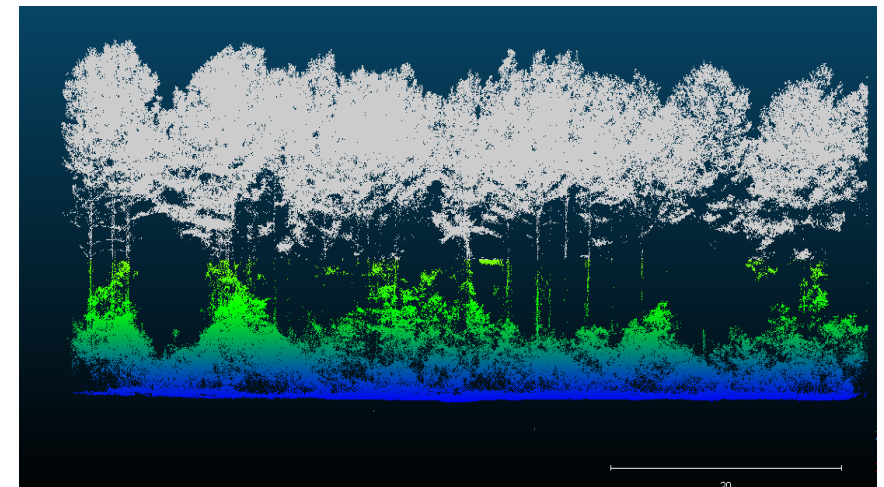


Herbicide is making more difference in growth than Fert

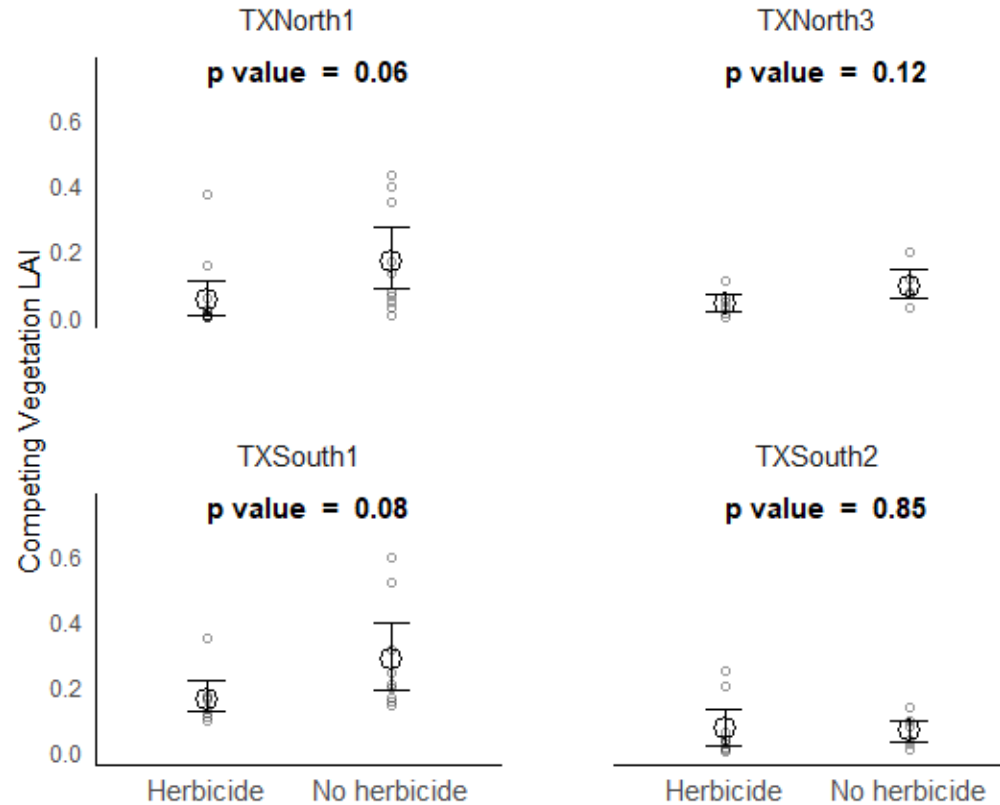# Results: LiDAR Competing vegetation height YST1

Herbicide



p value = 0.94
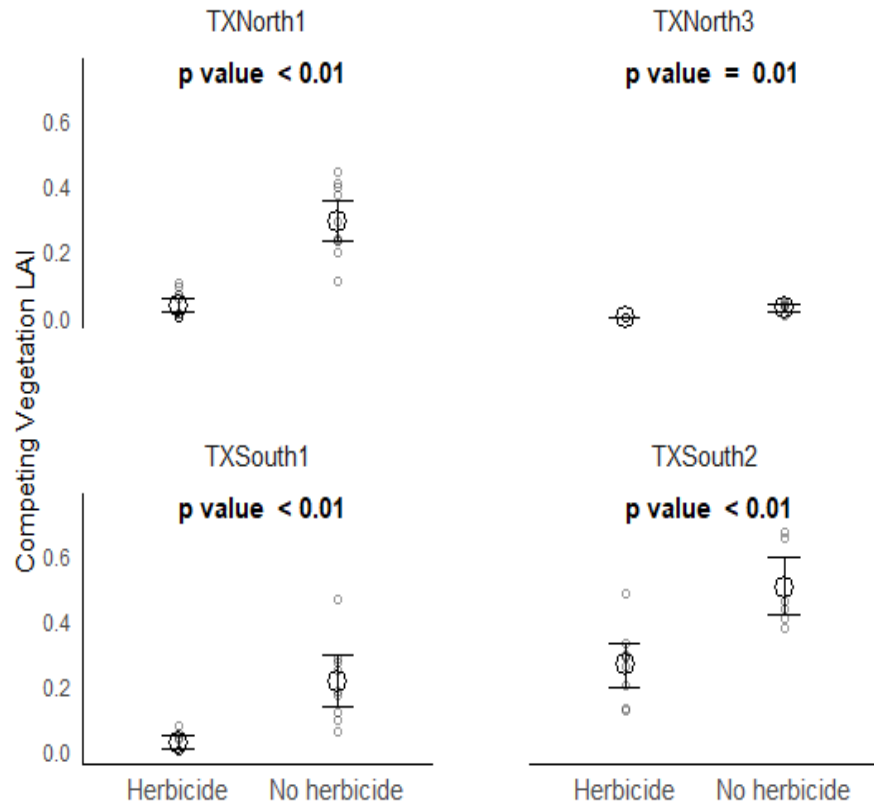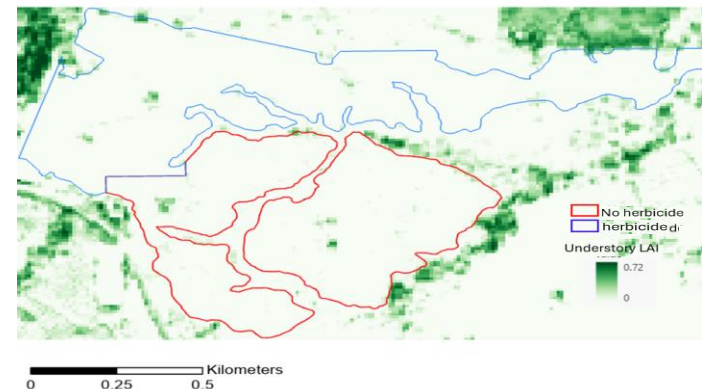
height

10 m

0 m

No herbicide

# Competing Vegetation LAI YST1

## LiDAR

## Satellite



Different species composition among stands (yaupon-evergreen vs blackberry- deciduous)

# Mean Tree Basal Area Growth:
# Competing vegetation LAI and Fertilizer

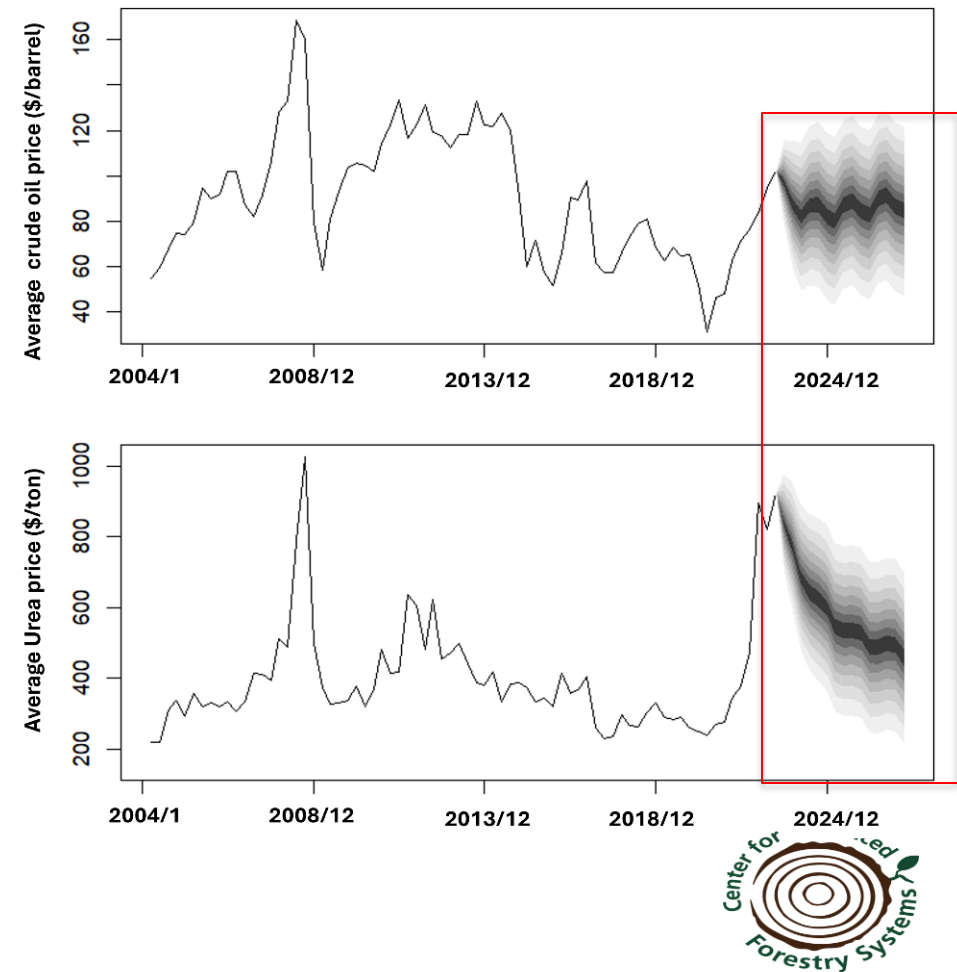| Coefficient | p-value |
|---|---|
| Intercept | <0.01 |
| Competing Vegetation LAI | 0.72 |
| Fertilizer Rate | 0.21 |
| Mean Basal Area YST1 | <0.01 |
| Stand:TXNorth3 | <0.01 |
| Stand:TXSouth1 | 0.88 |
| Stand:TXSouth2 | <0.01 |
| Competing Vegetation * Fertilizer Rate | 0.12 |
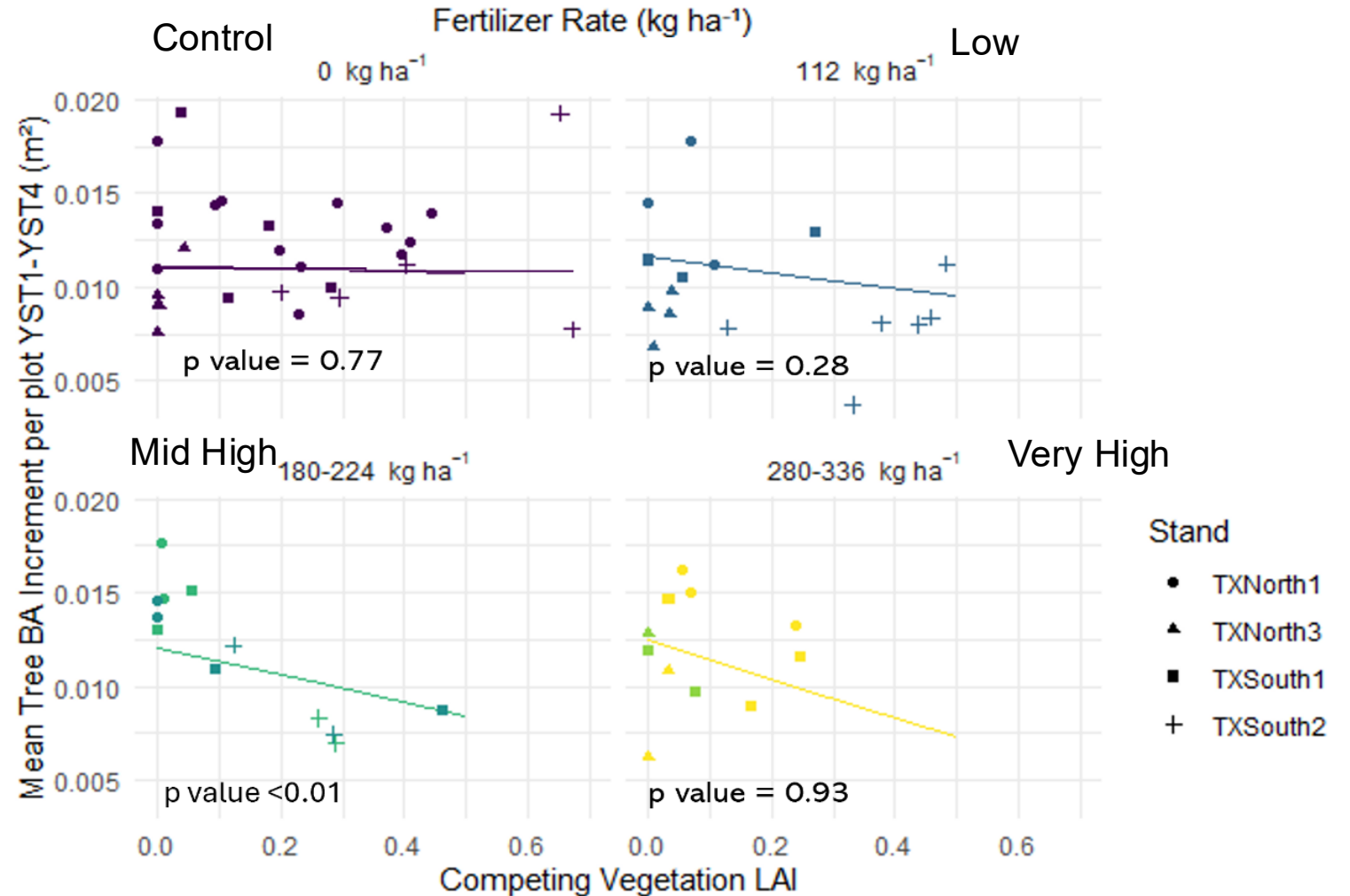
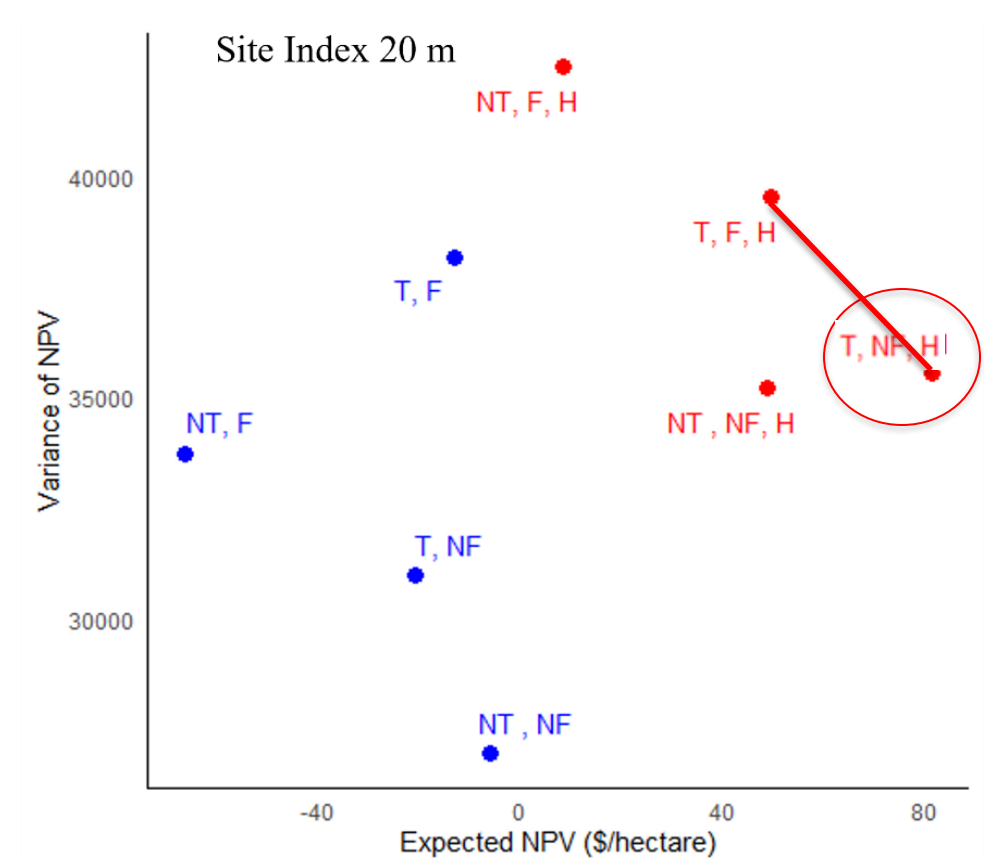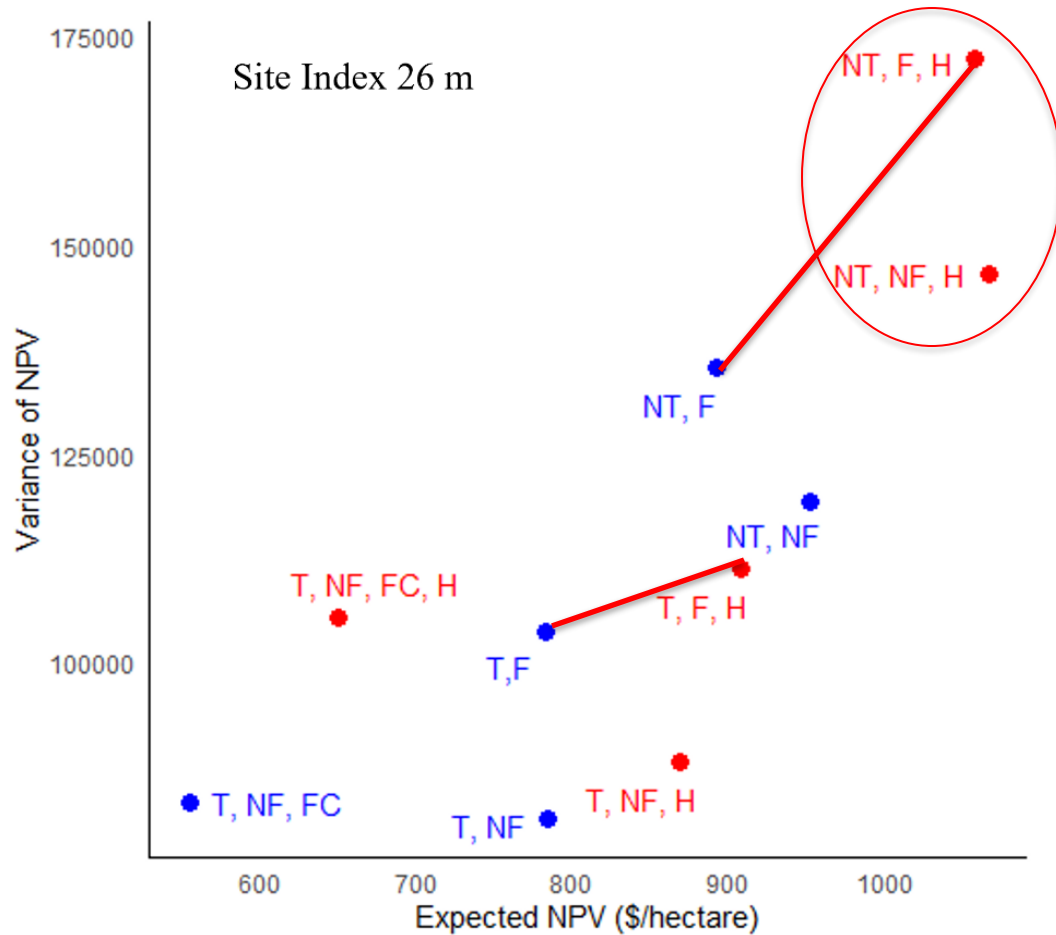# Looking Aheah: Timber and Urea Price Forecasting

Timber price
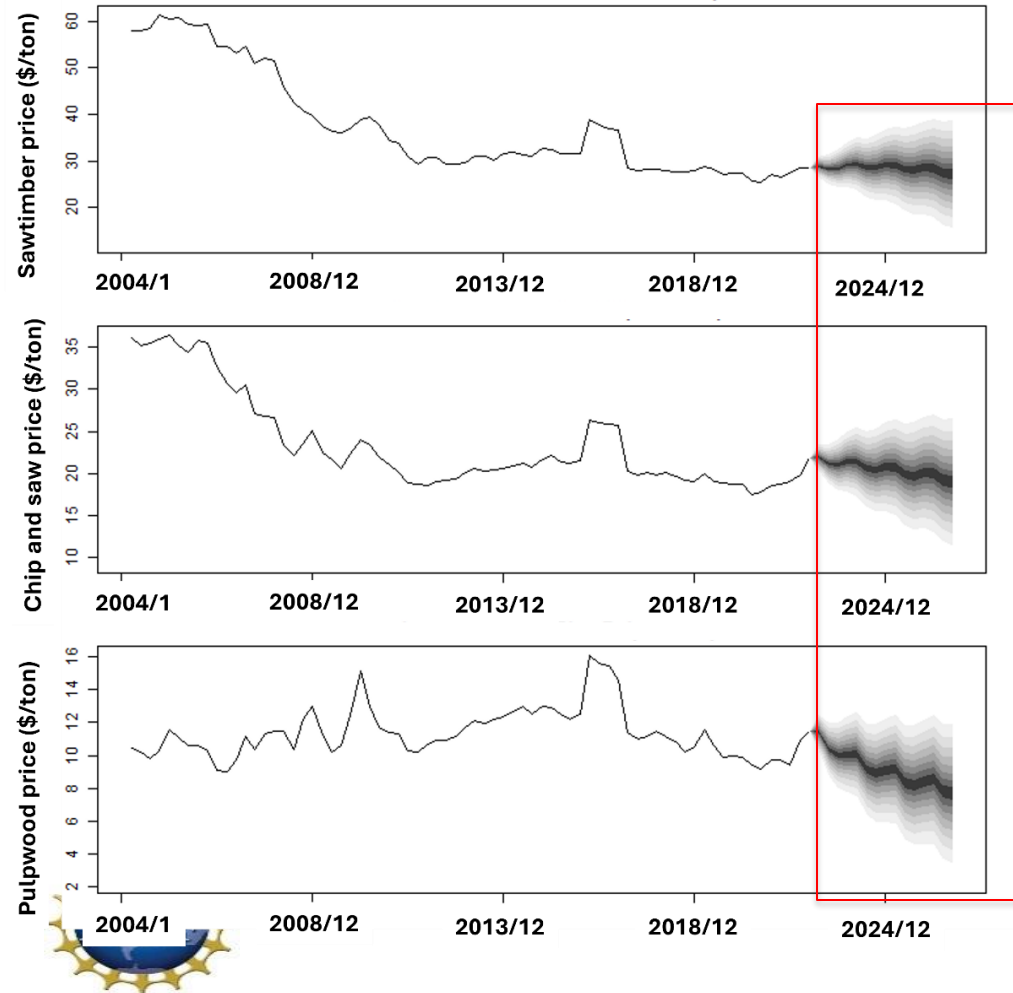


Urea price

# What is the Risk vs Reward for Silviculture Treatments

# Company Benefits

- Accessibility to LAI canopy layers

- Operational scale results from mid-rotation fertilization vs herbicide across soils and geology

- With time, ability to assess return on investment for: rates of fertilization and/or herbicide

- Determination of when/where LAI-based, variable rate fertilizer application can be beneficial.

- Combined with soils map and Site Index models: ability to estimate fertilizer response based on present canopy/understory conditions

# Summary

- **Study work ongoing**
  - Continuing to collect data in the field
  - New LiDAR acquisition Dec 2025/Jan 2026
  - Continuous satellite imagery
- **LAI and Deciduous Understory model improvements** are ongoing
  - Evergreen understory model in collaboration with Manulife
- **Integration of this work with soils and Site Index modeling**
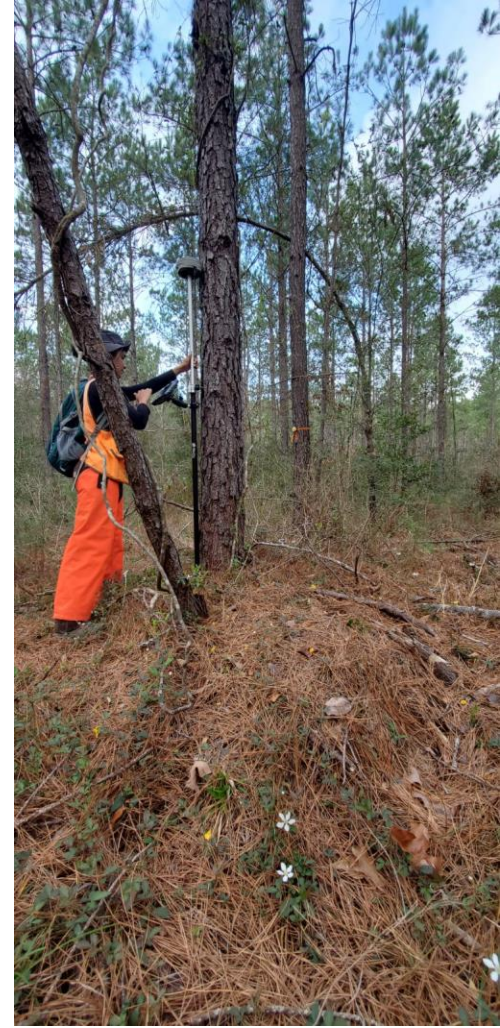
# Stand A: Deciduous Understory: Fert application x Herbicide



Mean(DUnder_MINMAX) & DUnder_MINMAX vs. fert_FINAL