Interpreting GIS Data and Developing Site-Specific Treatment Prescriptions for Precision Agriculture Applications

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Steps in Developing a Variable-Rate Treatment Prescription

Louisiana Agricultural Consultants Association 2008 Conference

Developing a Variable-Rate Treatment Prescription

1. Design a field trial for the purpose of obtaining data that will allow the comparison of treatments within the various management zones present in the field.

2. Perform the field trial according to the design to the extent possible. Note all problems and deviations from the design in performing the field trial.

Developing a Variable-Rate Treatment Prescription

3. Gather and process data
   a) Obtain data from various sources
   b) Consolidate using GIS software.
   c) Clean and possibly smooth data.
   d) Add additional variables that may be necessary for subsequent statistical analyses.
   e) Dataset format – one observation per yield point.
   f) Transfer data to statistician.

Developing a Variable-Rate Treatment Prescription

4. Statistical analysis of data
   a) Develop appropriate model based on design and performance of the experiment.
   b) Use model to compare treatments within the various management zones.

5. Extract results of the treatment comparisons necessary for building data structures for subsequent processing.

Developing a Variable-Rate Treatment Prescription

6. Build one or more treatment prescriptions.
   a) Identify actual or potential producer preferences.
   b) For each such preference, develop a preference specification and build a data structure that implements that preference specification.
   c) Combine the preference specification with the treatment difference information.
   d) Assign treatments to the field management zones.

Developing a Variable-Rate Treatment Prescription

7. Supply prescriptions to producer / researcher

   a) Graphs of the various treatment prescription options.

   b) Export each treatment prescription to a csv file or other appropriate format.

Developing a Variable-Rate Treatment Prescription

► The statistical analysis upon which the treatment prescription development process is based is dynamic in nature and requires flexibility in its implementation:

- depends on the experimental design
- depends on the data (e.g. nature of the covariates)
- requires statistical expertise
- changes as methodology improves and new software becomes available
- is therefore <u>not</u> a good candidate for automation

Developing a Variable-Rate Treatment Prescription

► The steps involved in developing a treatment prescription following the statistical analysis appears to be a

- systematic and relatively static process
- good candidate for automation

Software for Developing Treatment Prescriptions

Software for Developing Treatment Prescriptions

- ► We have developed specifications for a software system for creating treatment prescriptions.

- ► We have implemented the specifications in SAS

- ► Scripts have been developed to generate SAS code that meets these specifications.

- ► A variety of software could be used.

Software for Developing Treatment Prescriptions

► Statistical analysis - SAS, S-Plus / R, etc.

► Subsequent steps in the process

  ▪ Any database software, for example

    ► MySQL

    ► Access

    ► Oracle

  ▪ SAS

    ► Data step programming

    ► Proc SQL

Developing a Treatment Prescription for a Commercial Cotton Farm

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Turner Farm Field Trial

► Commercial cotton farming operation

► Embedded field trial conducted in 2006 to gather data for developing a variable-rate nitrogen treatment.

Turner Farm Field Trial

► Field characteristic data

- ■ Elevation
- ■ Soil electro-conductivity (EC)

Turner Farm Field Trial

► Elevation

- Spatially referenced
- Ranges from 39.66 to 41.03 ft

Turner Farm
Elevation Contours
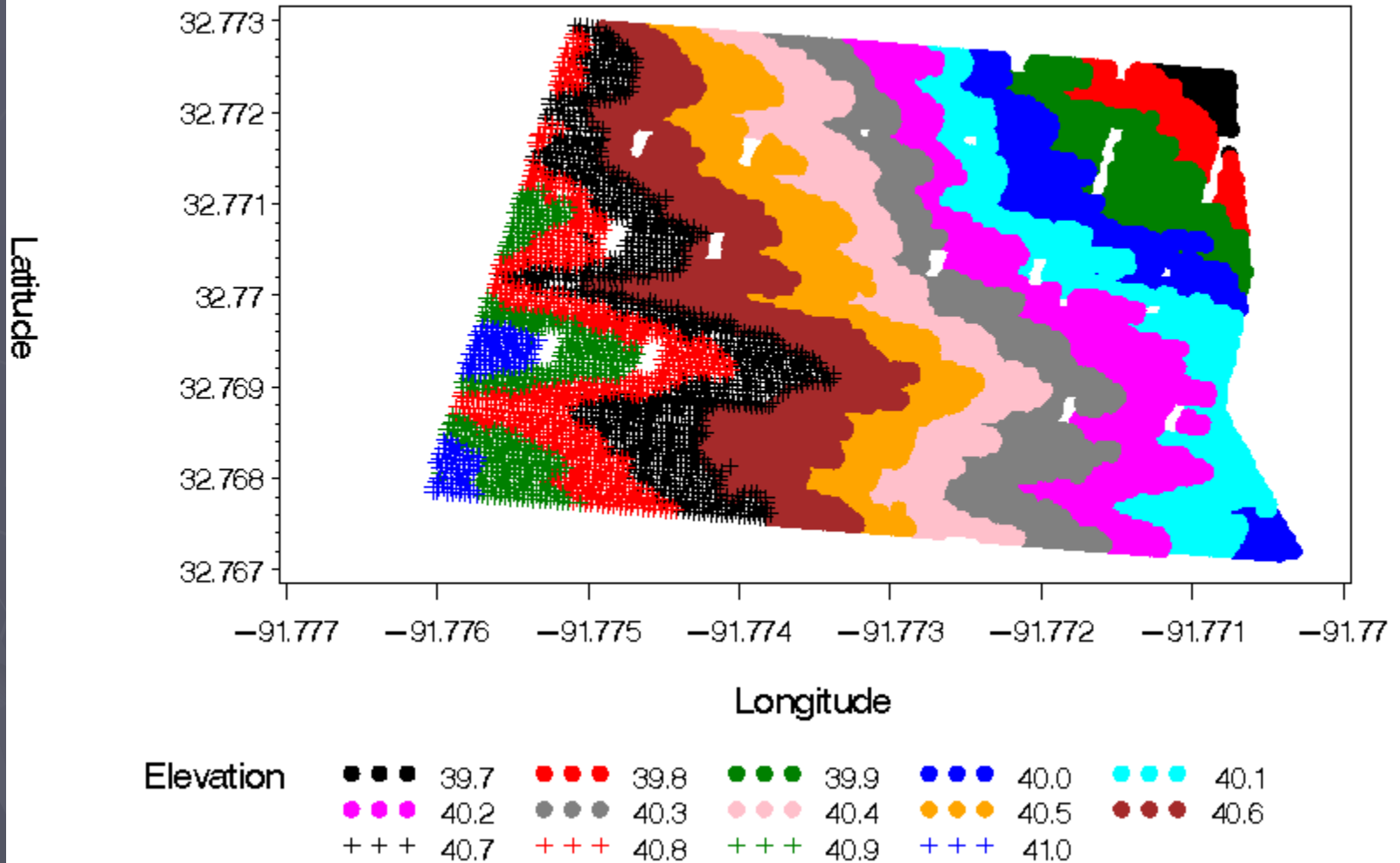
Turner Farm Field Trial

► Electro-conductivity (EC) measurements

- Used as a proxy for clay content
- EC_12 : Shallow EC (down to 12 in.)
- EC_36 : Deep EC (down to 36 in.)
- Spatially referenced

Turner Farm Field Trial

► Electro-conductivity (EC) measurements
- EC_Zone: $\{(EC\_12, EC\_36)\} \rightarrow \{1,2,3\}$
  - ► Defined by researchers
  - ► Classification by clay content:
    - EC_Zone 1 : Lowest amount of clay
    - EC_Zone 2 : Medium amount of clay
    - EC_Zone 3 : Highest amount of clay
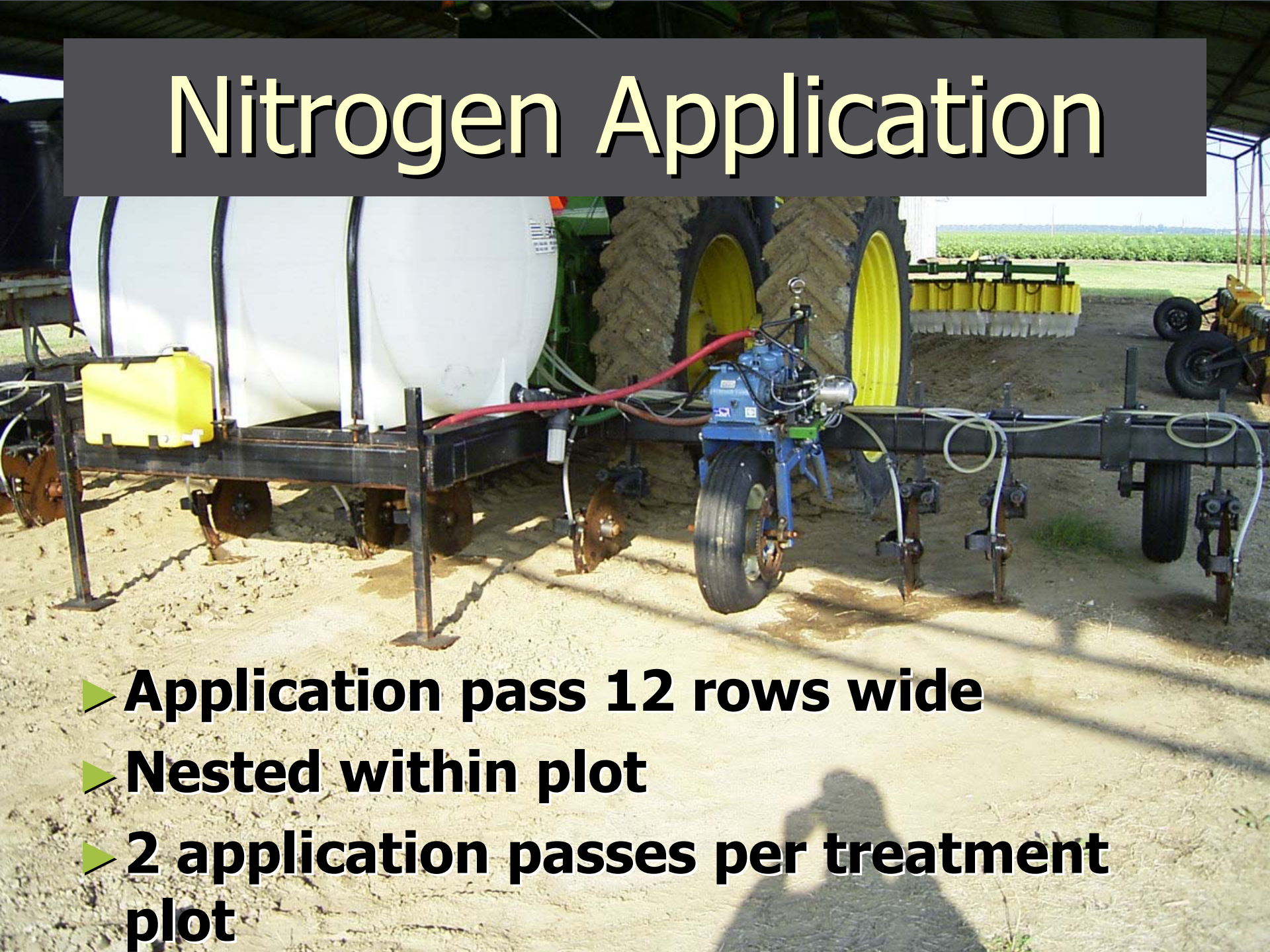
Turner Farm
Electroconductivity (EC) Zones

EC Zone EU ●●●● 1 ●●● 2 ●●● 3
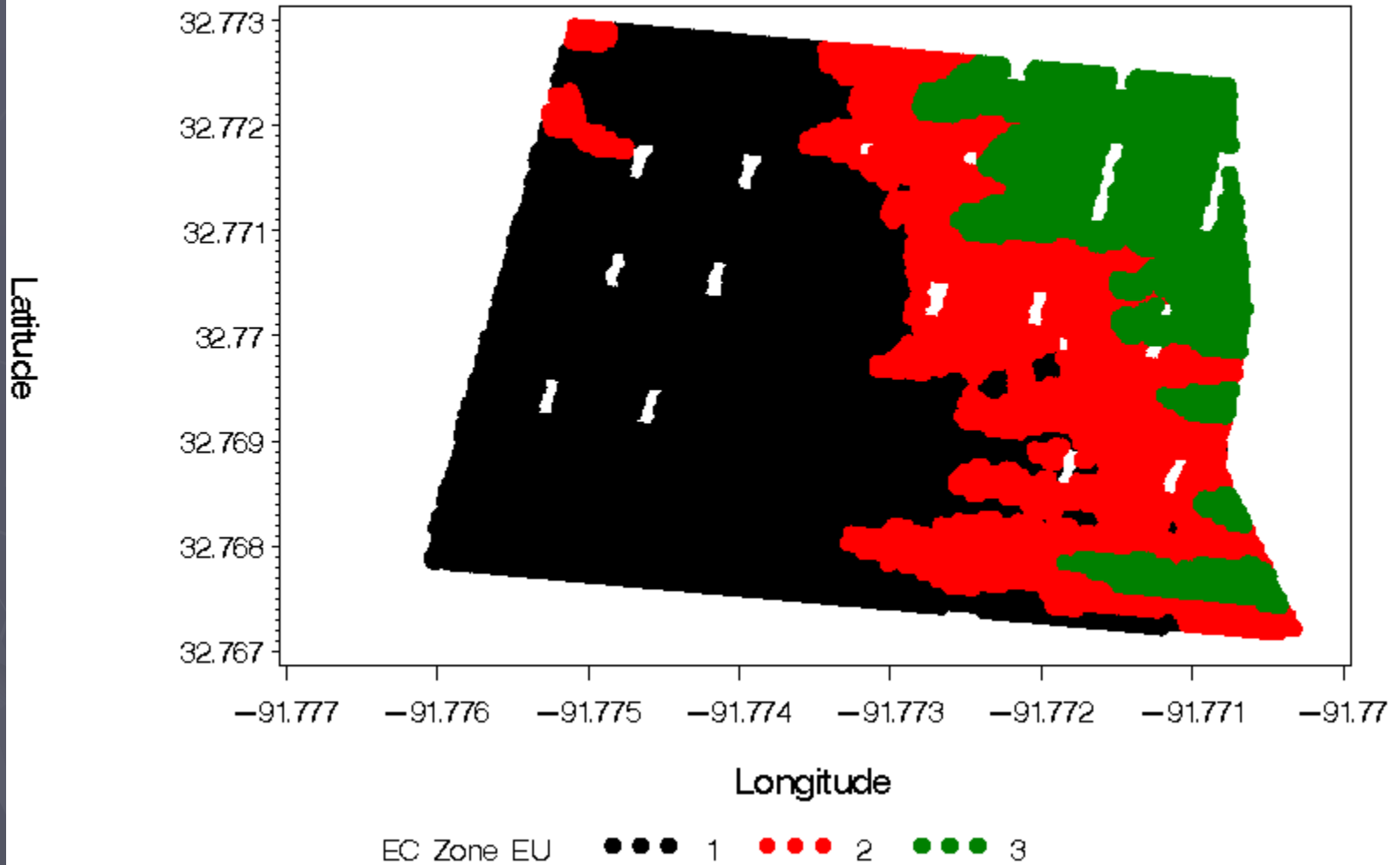
Turner Farm Field Trial Layout

► 3 Reps

► Nitrogen treatments randomly assigned to plots within reps

- Strips running entire length of field, as well as
- Embedded plots within such strips

► Plots were 24 rows wide

Turner Farm Nitrogen Treatments
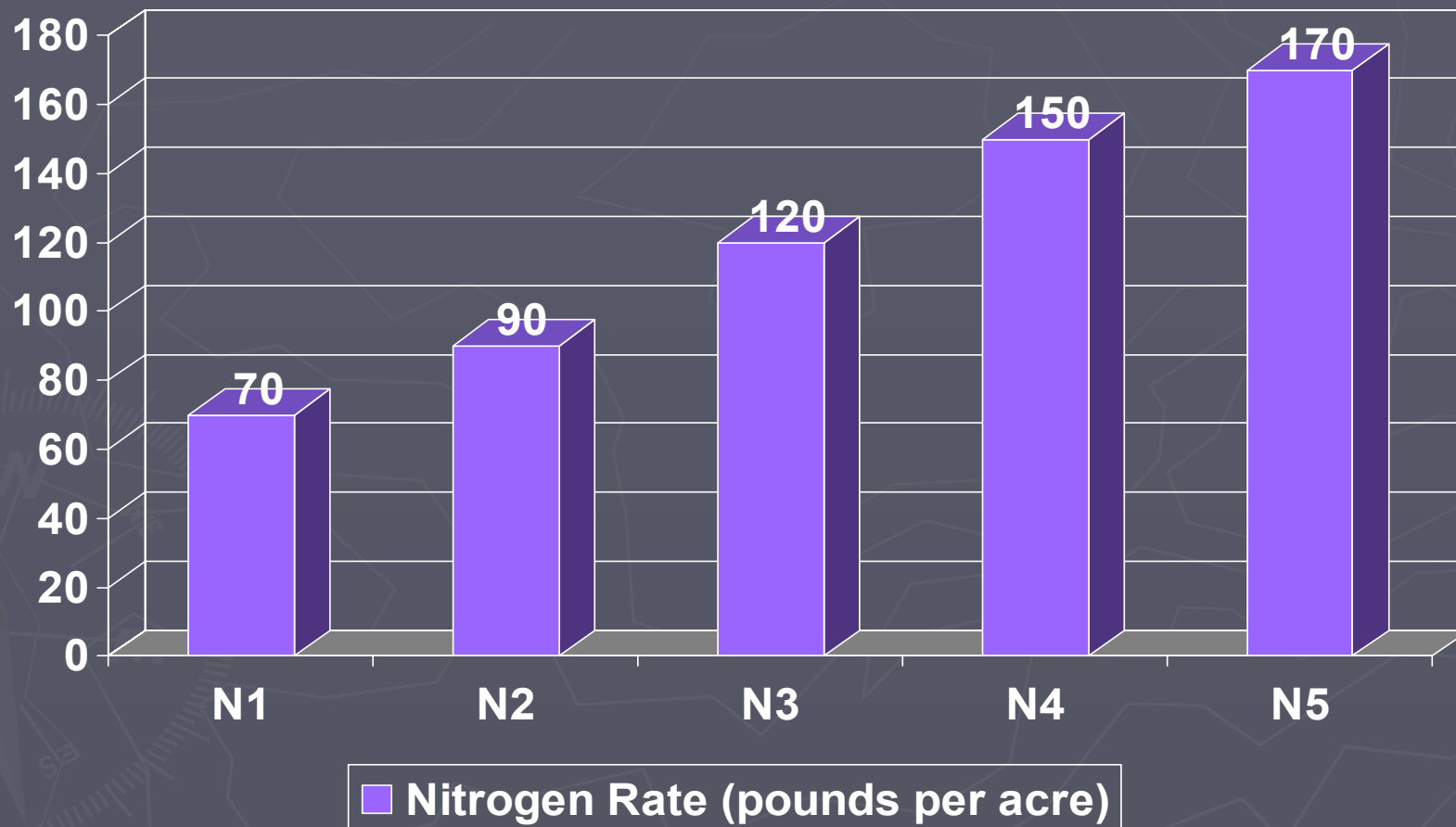
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Nitrogen Application

▶ **Application pass 12 rows wide**

▶ **Nested within plot**

▶ **2 application passes per treatment plot**

Harvest Passes

- **6 rows wide**
- **Harvest pass nested within application pass**
- **2 harvest passes per application pass**

Turner Farm Field Trial

► Response variable
  - Cotton lint yield
  - Measured every 2 seconds
  - Spatially referenced
  - Pounds per acre
  - GIS software was used to estimate elevation and EC values at each yield point location

Statistical Modeling

► Topological experimental design (TED)

- Willers, Milliken, O'Hara, et. al. (2004)

► Statistically analyze using a linear mixed model analysis of covariance incorporating spatial components

- Willers, Milliken, O'Hara, et. al. (2004)

► Implement using SAS Proc Mixed
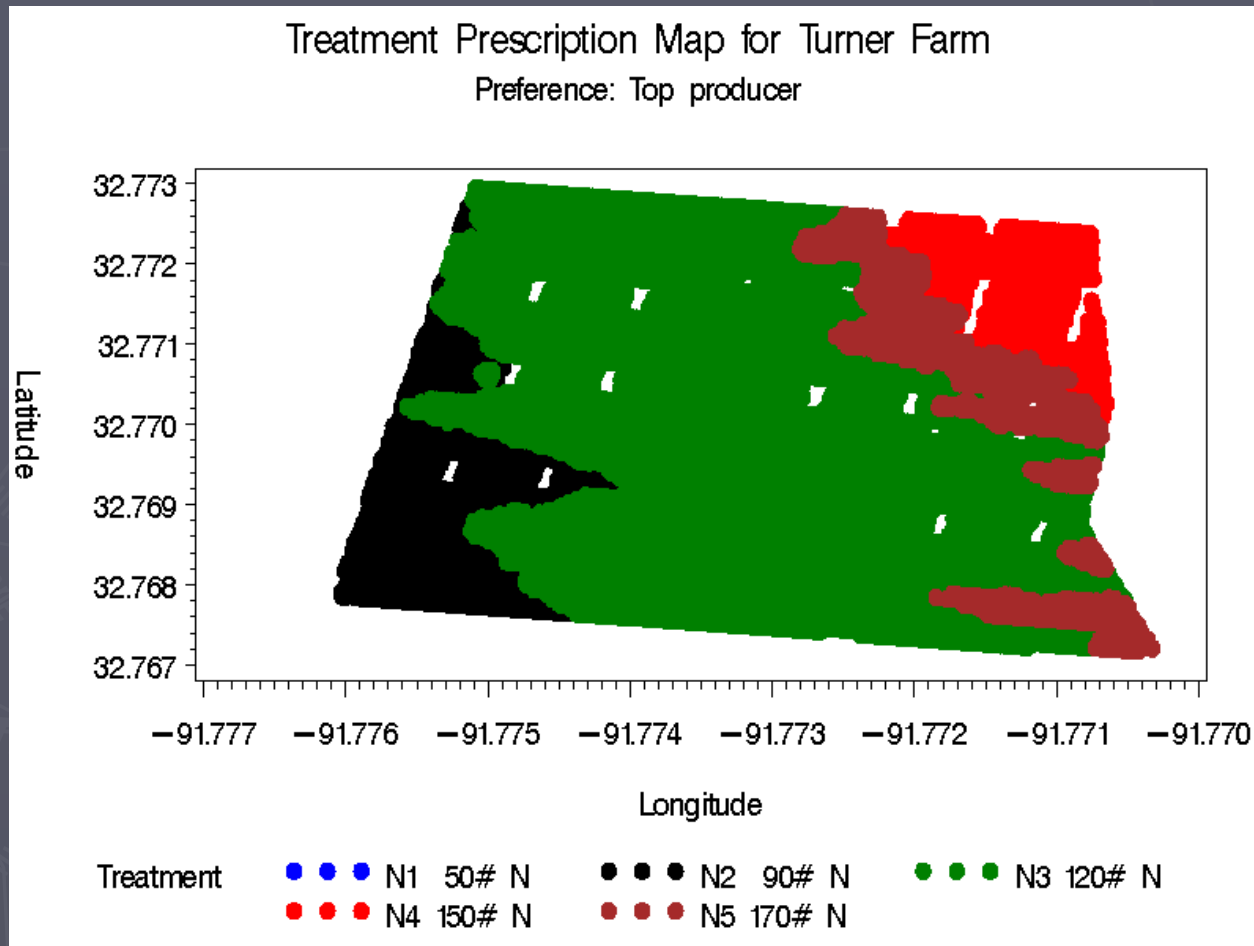
- Littell, Milliken, Stroup, et. al. (2006)

Preferences Specifications

► Preference Specification 1
  - Top Producer
  - At each level of EC_Zone and Elevation, choose the N rate that has the highest lsmean.

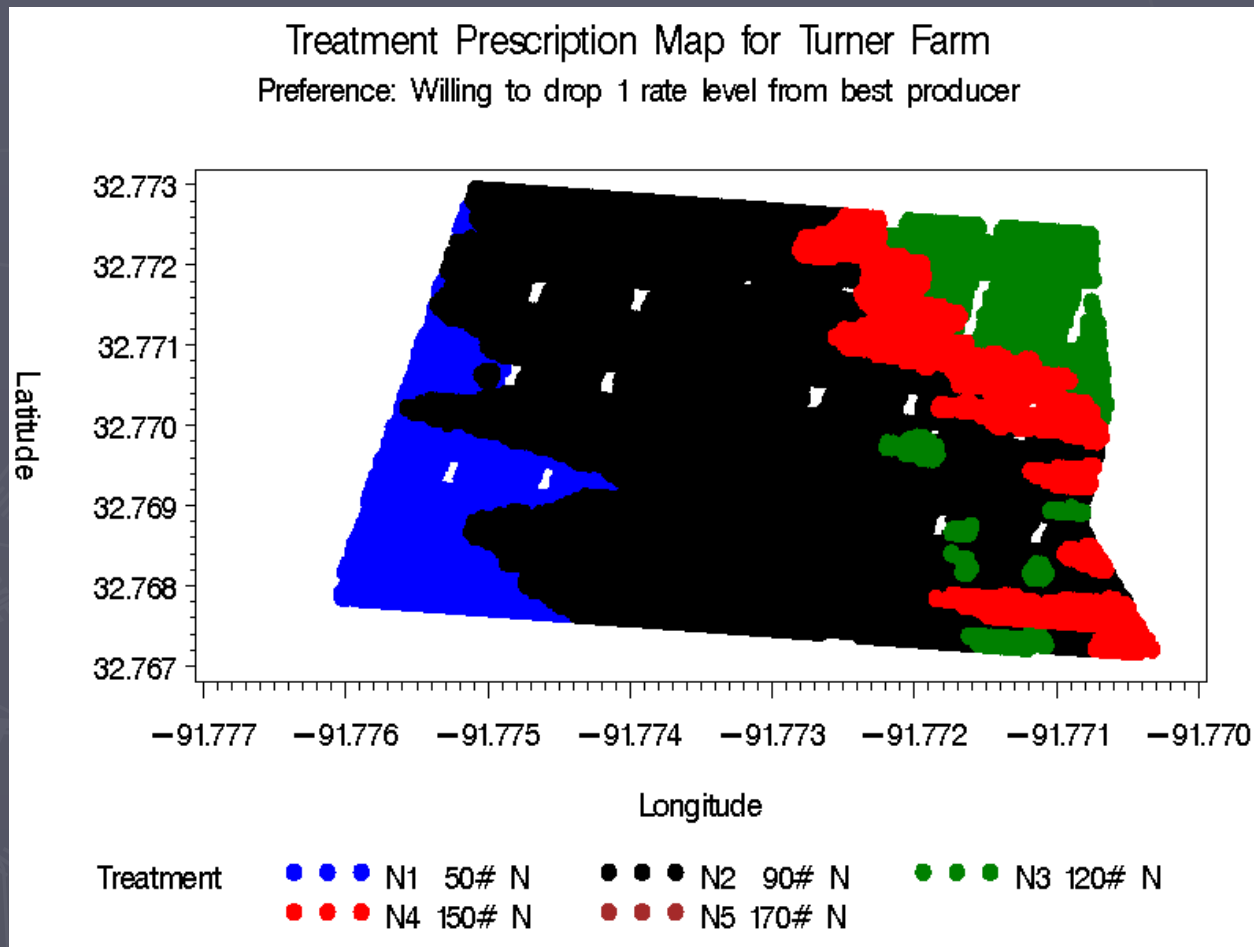► Preference Specification 2
  - Willing to drop up to 1 rate level

Preferences Specifications

► Preference Specification 3

  ▪ Willing to drop up to 2 rate levels

► Preference Specification 4

  ▪ At each level of EC_Zone and Elevation, choose the lowest N rate from the class of N rates that are not significantly different than the top producer.

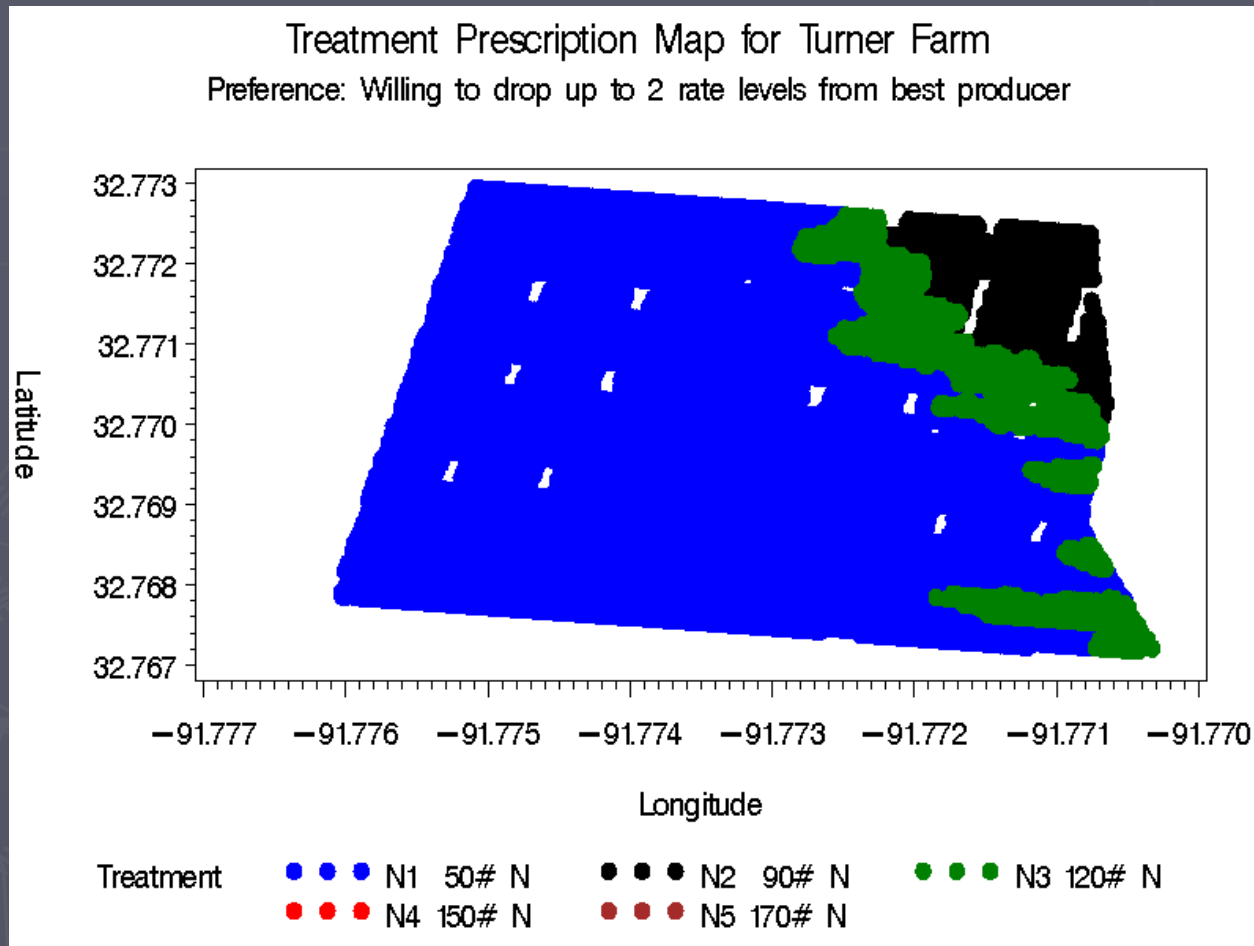 ▪ Can also be called the "willing to drop up to 4 N Rate levels" preference.

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Treatment Prescription 1

Treatment Prescription Map for Turner Farm
Preference: Top producer

Treatment Prescription 2

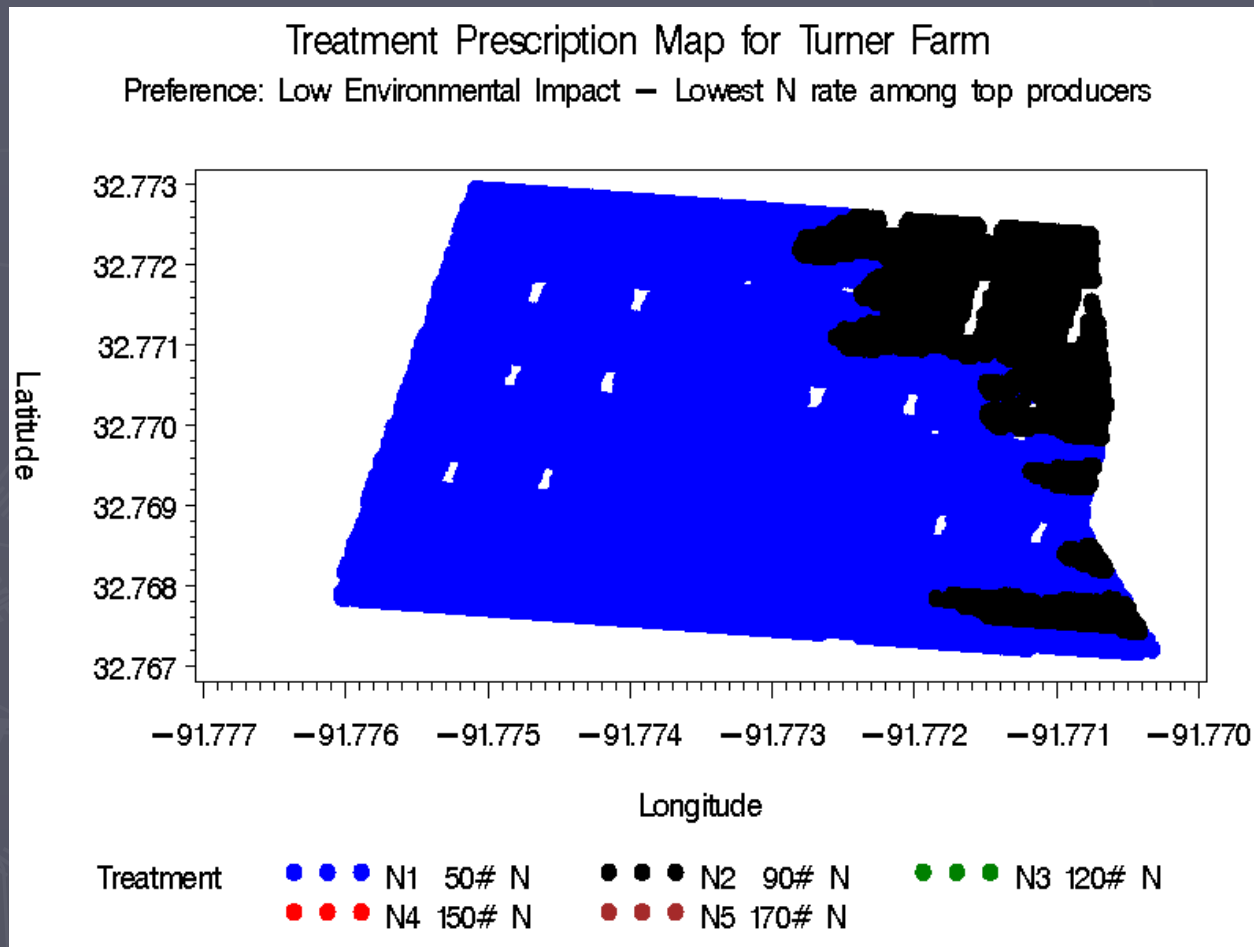Treatment Prescription Map for Turner Farm
Preference: Willing to drop 1 rate level from best producer

Treatment Prescription 3

Treatment Prescription Map for Turner Farm
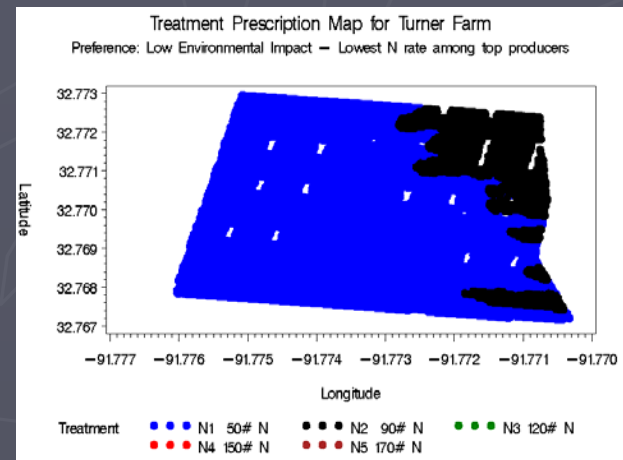Preference: Willing to drop up to 2 rate levels from best producer

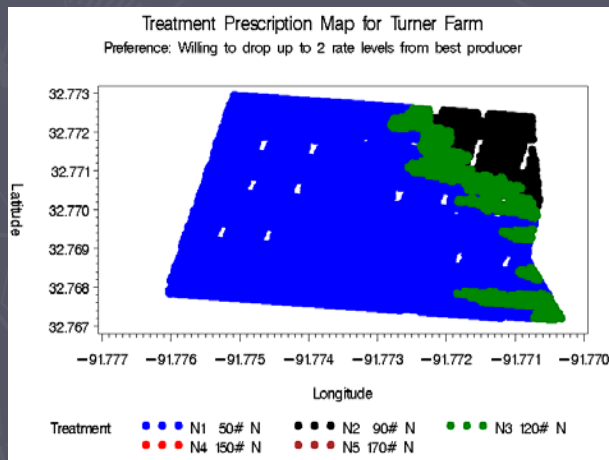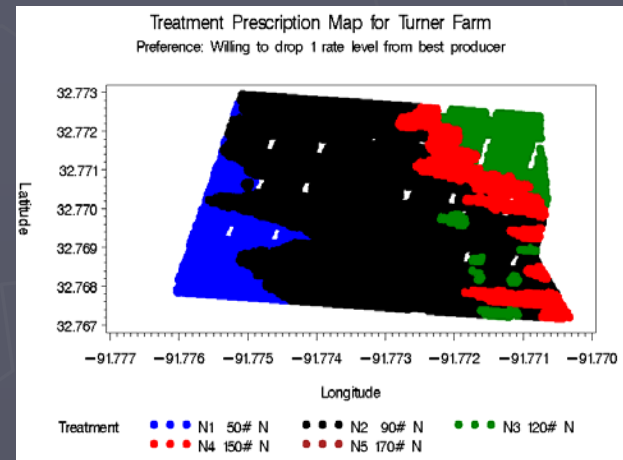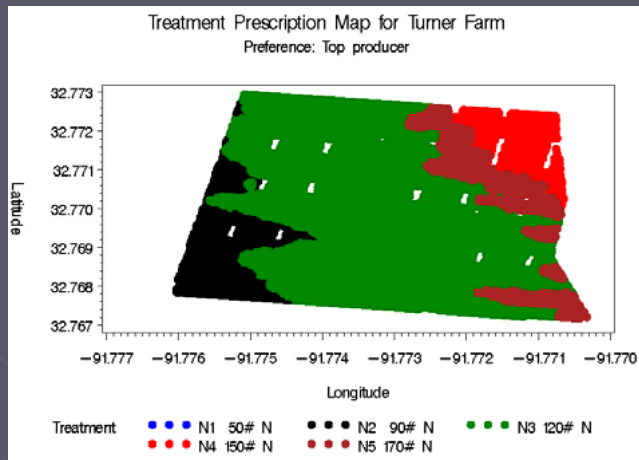# Treatment Prescription 4

Turner Field
Treatment Prescription Options

Prescription Based on Helena 2007 Field Trial

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Thank You!

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