Group Discussion

Questions

1. What information should I use as a basis for creating different management zones?
2. How do I create a standard/reproducible procedure for delineating unique management zones?
3. How many unique management zones should a field be divided into?
4. How to I validate the quality of my management zones after creation?

Various Data Layers – Question 1

2012 Corn Yield Map
Drought

2013 Soybean Aerial Imagery
Flash Drought

Various Data Layers – Question 1

1979 Soil Map
IDW Deep EC Map
Various Data Layers – Question 1

Historic 1941 Aerial Image

Deep Soil EC Data Points

What would your management zones look like for this field?

Management Zone Analyst – Questions 2 and 3

Overview – Management Zones

• History of Management Zones (MZs)
• Challenges
• Peer-Reviewed Research Results
• Nebraska On-Farm Research Examples
• Platforms
• Summary

History of Management Zones

Management Zones

Under the pivot and dryland pivot corners – 2 management zones
History of Management Zones – 1980s

- Concepts tested in the late 80s early 90s
  - Different from farming by soil series in the early 80s
  - Variability was significant within soil series boundaries, needs to be determined by grid or transect
- “Each management zone should ideally represent portions of the field that are relatively similar and homogeneous in soil fertility status so that a different uniform fertilizer recommendation can be made for each zone”


History of Management Zones – 1990s and early 2000s

- Late 90s: “Are sub-regions of a field that express a homogeneous combination of yield-limiting factors for which a single crop input is appropriate”
- Common approaches for delineating MZs:
  - Soil texture and OM
  - Electrical conductivity mapping
  - Remoting sensing
- Less commonly used were yield mapping and elevation


History of Management Zones – 2000s

- Yield history and multi-year analysis utilized more frequent to create management zones
  - Software program that could take numerous types of data layers to help delineate zones
  - Standardized procedure
  - Allowed user to determine number of zones

Challenges
Challenges with various data sources

Yield Spatial Variability
• Measures yield difference among subfields within a field in a given year

Yield Temporal Variability
• Measures yield difference among fields subfields across years
• Often greater than spatial variability

What Yield Maps Should I Use?

Corn only
Include available years
Use multi-year average

Corn only
All except extremes
Use multi-year average

Soybeans only
Include available years
Use multi-year average

Soybeans only
All except extremes
Use multi-year average

Corn and Soybeans
Yield index
Run for specific scenarios and years (wet, average, dry)

Corn and Soybeans
Include all years
Use Relative Yield/Index

Challenges with various data sources

Yield
• Plant integrate all environmental factors
• Input or management interaction across the field
• Spatial and temporal variability are a real change

Study by Bunselmeyer and Lauer (2015)

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Tillage</th>
<th>Time to Consistent Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous corn</td>
<td>Conventional till</td>
<td>4</td>
</tr>
<tr>
<td>Continuous corn</td>
<td>No-till</td>
<td>20</td>
</tr>
<tr>
<td>Rotated Corn</td>
<td>Conventional till</td>
<td>20</td>
</tr>
<tr>
<td>Rotated Corn</td>
<td>No-till</td>
<td>20</td>
</tr>
<tr>
<td>Continuous soybean</td>
<td>Conventional till</td>
<td>18</td>
</tr>
<tr>
<td>Continuous soybean</td>
<td>No-till</td>
<td>18</td>
</tr>
<tr>
<td>Rotated soybean</td>
<td>Conventional till</td>
<td>10</td>
</tr>
<tr>
<td>Rotated soybean</td>
<td>No-till</td>
<td>24</td>
</tr>
</tbody>
</table>

Soil Electrical Conductivity
• Significant relationship for 9 out of 13 site-years
• Climate, crop type, and specific field information needed to explain shape of the interaction


How many sets of management zones do we need and assumptions often made

• Management zones for:
  • For each crop (corn and soybeans separate or together)
  • Seeding rates
  • Hybrid/variety placement
  • Seed treatment placement
  • Irrigation
  • Fertilizer
  • Pests: Weeds, insect, diseases

• Assumptions:
  • We can easily create management zones for whole-farm datasets
  • Once management zones are create, they don’t need to change
  • We capture a majority of the spatial and temporal variability with management zones
  • Some constant factors on yield over time (i.e. soil texture)
  • Response (yield and return) to each input by management zone is known
  • No input by management zone interactions

Peer Reviewed Publications
Using Corn and Soybean Yield History to Predict Subfield Yield Response

Situation
- Yield history often used to delineate management zones in a field.
- Questions remain about the type and amount of data required to classify subfields into management zones
- How many years of yield history is needed to identify a consistent yield pattern within a subfield?

Materials and Methods

Study 1
- Plano silt loam near Arlington, Wisconsin
- 1987-2012 - 26 years
- Crop Rotations
  - Continuous corn
  - Rotation corn-soybean
  - Continuous soybeans
- Tillage
  - Conventional till
  - Fall chisel plow
  - 2x spring field cultivator
  - No-till

Study 2
- Plano silt loam near Arlington, Wisconsin
- 2003-2012 - 10 years
- Crop Rotations
  - Continuous corn
  - Rotation corn-soybean
  - Continuous soybeans
- Tillage
  - Conventional till
  - Fall chisel plow
  - 2x spring field cultivator
  - No-till

Materials and Methods

Results and Discussion

• It can take 4 to 20 years even with long-term management practices for consistent yield patterns to persist.
  - Can corn yield be used to predict soybean yield and vice versa?
  - 87% of the subfields had the same trend for both corn and soybean yield
  - 9% of the subfields ranked low for corn yield, but high for soybean yield
  - 4% of the subfields ranked high for corn yield, but low for soybean yield

Conclusions

• Many years of yield needed to define consistent patterns of subfield yields
• Subfield yield temporal variability is greater than spatial yield variability
• Classifying subfields into management zones for input prescriptions remains challenging

Peer Reviewed Publications
Combining Spatial and Temporal Corn Silage Yield Variability for Management Zone Development

• Authors
  - Tulsi P. Kharel et al.
  - From Cornell University
  - Published in 2019
  - Agronomy Journal 111:1-9

• Situation
  - Yield data from multiple years are standardized and relative yield values are used to development management zones.
  - However, fields and areas within fields can vary both spatially and temporally.

Materials and Methods

• Study
  - Six farms in New York
  - Data from 2015, 2016, and 2017
  - 78 fields
  - Corn silage yield
  - Used USDA Yield Editor and SMS Advanced from AgLeader

Quadrant 1
- High Yield
- Temporal Stability

Quadrant 2
- High Yield
- Temporal Instability

Quadrant 3
- Low Yield
- Temporal Stability

Quadrant 4
- Low Yield
- Temporal Instability

Results and Discussion

• Stables zones easier to manage as yield can be predicted in advance with greater accuracy.
  - 56 to 70% of the field

• Potential for increasing production efficiency with within-season precision ag management.
  - 44 to 30% of the field

• Need to determine yield-limiting factors and accurately predict crop response to management under various weather scenarios.

• Need to define the appropriate number of zone per farm to address spatial and temporal variability.

Conclusions

• Spatial and temporal variability were not correlated (Field 2).
• Each substantial enough to warrant the development of stability-based yield zones that minimized input or maximized output.
• A whole-farm quadrant-based approach eliminates problems with single-field and relative yield-based management zones.
• No BMPs on the number years needed.

Peer Reviewed Publications

Validating a Digital Soil Map with Corn Yield Data for Precision Agriculture Decision Support

• Authors
  - C. W. Bobryk, N. Kitchen, S. Drummond et al.
  - From USDA-ARS and University of Missouri
  - Published in 2016
  - Agronomy Journal 108:957-965

• Situation
  - Managing variability in crop production is complex due to interactions in GxE,M
  - Genetic potential (G)
  - Biosphysical environment (E)
  - Management activity (M)
  - Need for improved digital soil maps for precision ag management decisions.
Materials and Methods

- Study
  - NE, MN IA, and IN
  - Data from 2010, 2011, and 2012
  - 409 fields
  - Corn yield
- This new digital soil map (DSM) called environmental response unit (ERU) was the product of a public-private collaboration between the USDA-ARS, University of Missouri, and Dupont Pioneer

Materials and Methods

- Study
  - SSURGO enhanced with LIDAR data
  - 16.5 x 16.5 ft mapping resolution
  - Eliminated ERUs smaller than 0.5 acres

Results and Discussion

- 57% improvement within ERU over SSURGO
- The yield variance reduction differed from year to year and state to state, but the greatest variance reduction was in 2012.

Conclusions

- Study used corn yield maps from in combination with a variance reduction algorithm to validate a high resolution ERU DSM
- The ERU DSM provided a great reduction of corn yield variance than SSURGO
- The process was able to classify soil and landscape characteristics in a way that will allow for improved precision ag management applications

Nebraska On-Farm Research Examples

- Planter technology allows growers to change seeding rates within a field.
- Goal: Optimize yield/economics. Put more seeds where we can push to get a higher yield response, put less seeds where the soil/fertility cannot support it.
- Companies offer ready to use seeding rate prescriptions
Variable Rate Seeding

• UNL Extension/On-Farm Research Recommendation: TEST IT.
  1. Management zones for seeding rate by Helena tool
  2. Seeding rates evaluated with blocks of each rate multiple time in each zone. Implemented with VR seeding capabilities on the monitor/planters.

Management Zones for Variable Rate Seeding Studies (multi-year yield history)

<table>
<thead>
<tr>
<th>County</th>
<th>Treatment</th>
<th>Yield (bu/ac)</th>
<th>Net Return ($/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lancaster</td>
<td>20,000</td>
<td>158B</td>
<td>-</td>
</tr>
<tr>
<td>Lancaster</td>
<td>Variable Rate (24, 28, 32K)</td>
<td>206A</td>
<td>716.00</td>
</tr>
<tr>
<td>Lancaster</td>
<td>Variable Rate (24, 28, 32K)</td>
<td>205A</td>
<td>710.00</td>
</tr>
<tr>
<td>Lancaster</td>
<td>25,000</td>
<td>200A</td>
<td>730.00</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Variable Rate (17, 21, 24K)</td>
<td>131A</td>
<td>387.31</td>
</tr>
</tbody>
</table>

Bushels per acre corrected to 15.5% moisture
Values with the same letter are not significantly different at the 90% confidence level

Lancaster County (2013)

Source: https://cropwatch.unl.edu/farmresearch/articlearchives/vr-seed-experiments

Resources


CropWatch Variable Rate Seeding Considerations: https://cropwatch.unl.edu/farmresearch/articlearchives/vr-seed-experiments

Multi-Hybrid

• Ability to place different hybrids in different portions of the field to best match genetics and environment
• Goal: place hybrids that have some trait that will make them perform better in the area they will do best.
• Examples:
  • Place hybrids with greater drought tolerance where soils have lower water holding capacity
  • Used treated seed for SDS prone areas within a field and non-treated seed in non-SDS areas

Multi-Hybrid

• Research at UNL – Stevens, et al. 2018
  • 10, full field scale corn research sites
  • Drought tolerant hybrid (defensive) and offensive hybrid
  • Many sites showed that one hybrid was better for the entire field
  • Where there were differences, the zone delineation was not stable from year to year
2016 and 2017 multi-hybrid planting and management zones

- Aerial Imagery

Multi-hybrid planting 2016 & 2017 in Dodge County

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Defensive Hybrid</th>
<th>Offensive Hybrid</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defensive Zone</td>
<td>230</td>
<td>233</td>
<td>0.7046</td>
</tr>
<tr>
<td>Offensive Zone</td>
<td>242</td>
<td>252</td>
<td>0.1521</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defensive Zone</td>
<td>212</td>
<td>215</td>
<td>0.2398</td>
</tr>
<tr>
<td>Offensive Zone</td>
<td>236</td>
<td>236</td>
<td>0.1156</td>
</tr>
</tbody>
</table>

What should have been the management zones

- Research at UNL – Stevens, et al. 2018
- 4 soybean seed treatment sites
- Goal – place ILeVO seed treatment for sudden death syndrome in portions of the field where disease is generally more prevalent (generally soils that are more frequently ponded).

Multi-Hybrid

- The drastic yield difference between the ILeVO and standard treatment in the SDS zone resulted in a $79 advantage for using the ILeVO treatment.
- Considering the size of the SDS zone (around 50 acres), the additional return by using the ILeVO treatment would equal around $4,000 for the field.
- If the additional cost of a multi-hybrid planter is around $20,000, the technology could be paid off in around five soybean growing seasons in this field.
Platforms

Management Zone Analyst

Granular

• Formerly called Encirca
• We review the publication earlier on this process

How does the quality of ERU compare to SSURGO?

- ERU

Climate FieldView™ Nitrogen Advisor

Climate FieldView™, acquired by Monsanto 2013; Monsanto acquired by Bayer 2018

Adapt-N

Developed by Cornell University, acquired by Yara for scaling

Field Variability and Management

• Companies are taking advantage of “data mining” techniques to offer advice to farmers
Numerous GIS Platforms
- AgLeader SMS
- John Deere Apex
- FarmWorks

Summary
- What information should I use as a basis for creating different management zones?
- How do I create a standard/reproducible procedure for delineating unique management zones?
- How many unique management zones should a field be divided into?
- How to I validate the quality of my management zones after creation?