2006 Beltwide Cotton Conferences, San Antonio, Texas - January 3 - 6, 2006

SELECTION OF COTMAN SAMPLING POINTS USING HISTORICAL SITE-SPECIFIC DATA SETS

Randy W. Clouse and Stephen W. Searcy
Texas A&M University
College Station, TX

Abstract

Yield maps allow characterization of productivity throughout fields on a yearly basis. Combinations of yield maps across years could potentially allow producers to determine consistent yield areas in fields. A procedure was evaluated for using multiple years of yield data to potentially reduce the number of sampling points needed for the COTMAN crop monitoring system. Average yielding areas for the procedure were defined as areas within plus or minus 20 percent of the mode of the yield data distribution. The procedure was evaluated with data from three fields in Texas and one in Arkansas. Larger variability than expected was observed in COTMAN growth curves from the areas defined as average leading to the conclusion that reducing the number of sampling points would fail to capture this variability.

Introduction

COTMAN is a tool for tracking the development of cotton plants in a farm field during a growing season. It aids in decision-making for irrigation timing, defoliation timing and insecticide termination. Studies have shown that decision-making utilizing the COTMAN system can be more profitable as compared to not using the system (Benson et al. 2000). For recommended use four sampling points are selected in fields of up to 40 acres. Each additional 10 acres above 40 should have another sampling point. The points selected for sampling should characterize average growing conditions in the fields.

Precision agriculture data sets such as yield maps and remotely sensed imagery are becoming more widely available. These data sets allow characterization of spatial variability across each field. Spatial patterns in fields will be affected by the weather in a particular growing season. Combining data sets from different growing seasons would allow areas of consistent growing patterns to be identified including the effect of weather variability in the analysis. If COTMAN points could be selected from areas of the fields that consistently have average growing conditions, potentially fewer points could be used.

The objective of this study is to test whether the use of detailed historical field data can provide for selection of a limited number of sampling locations that are typical of average field conditions.

Methodology

Processing Procedure

The following steps were followed for determining consistently average producing areas of fields:

1) Visual and statistical examination of yield data.
2) Standardization of yield points using mode of yield data.
3) Development of continuous yield surface from yield data.
4) Selection of break points for yield surface classes.
5) Intersection of classes for different yield conditions (average and high) from different years

Field Experiments For Testing Procedure

The proposed procedure was tested with data from four fields. Three fields were from the Texas Agriculture Experiment Station in Burleson County, Texas and one field was from an experiment located at Marianna Arkansas. The fields at the Burleson County site were identified as I1, I2, and D3/D4. The fields in the tests represented both continuous cotton and a cotton-grain rotation (Table 1). Three of the fields, I1, I2 and the Arkansas field were under center pivot irrigation, while the fourth field, D4, had dryland management. The soils and area for each of the experimental fields is shown in Table 2. Three soil types, shallow sand, silty clay loam, and sandy loam existed in the fields tested. The field area for the test sites ranged from 9.71 to 26.30 ha.

Table 1. Crops grown for each year of yield data.

Field	2001	2002	2003	2004
Impact – I1	Cotton	Grain	Cotton	Grain
Impact – I2	Cotton	Cotton	Cotton	
Impact – D4		Grain		Grain
Arkansas			Cotton	

Table 2. Soils and field size for yield data.

Field	Soil	Area (ha)
Impact – I1	Shallow Sand	26.30
Impact – I2	Silty Clay Loam	9.71
Impact – D4	Shallow Sand	10.12
Arkansas	Sandy Loam	14.76

The average yield area processing procedure was applied to each data set. Sampling points were selected for fields I1 and D3/D4 with a modified version of the procedure that used classes based on the mean of the data set +/- 0.5*Standard deviation. Sampling points were already selected for field I2 and the Arkansas data and were only classified based on the areas determined in the processing procedure. COTMAN data was collected on a weekly basis during the 2005 growing season at all three fields, I1, I2, and D3/D4 in Burleson county. COTMAN data was previously collected during the 2003 growing season for the Arkansas field.

Results

The processing procedure is illustrated below with data from the Texas Agricultural Experiment Station in Burleson County, Texas. The data sets were from the 2001 through 2004 growing seasons. In these growing seasons, cotton was alternated with grain crops with cotton starting in the 2001 growing season. Step one, examination of yield data is illustrated with figures 1 through 4 for the 2001 and 2002 growing seasons. The cotton yield data in 2001 had a nearly identical mean and mode value, while the grain yield data from 2002 had the mean nearly 150 bushels per acre less than the mode. Next, an interpolated surface is developed from point yield data. The surface developed in this step for the 2001 cotton yield data is shown in figure 5. The contours shown in this surface are based on the data set standardized by the mode plus and minus twenty percent of the mode. The average area grouping for the 2001 cotton yield is shown groupings in figure 6. A map showing the average yielding areas for the 2002 grain yield data is shown in figure 7. Figure 8 shows the geographic intersection of the average yielding areas of the field in 2001 and 2002. The average yielding areas of the field with additional yield data from 2003 and 2004 is shown in figure 9. With the additional years of yield data the portions of the field classified as average yielding has decreased (figure 10). There is approximately a ten percent decrease in average yielding area with each additional year of yield data intersected.

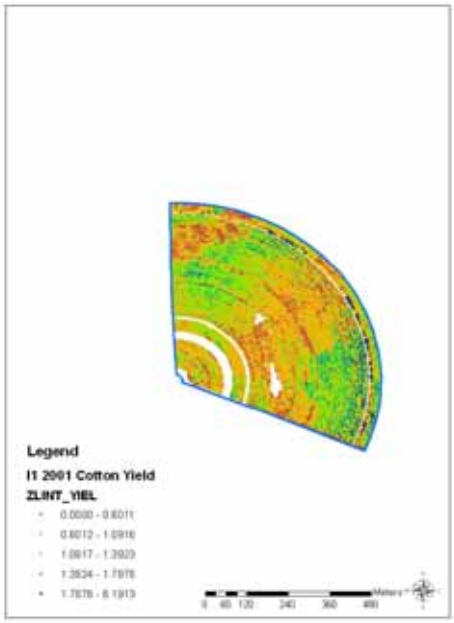

Figure 1. Cotton yield data for field I1 in 2001.

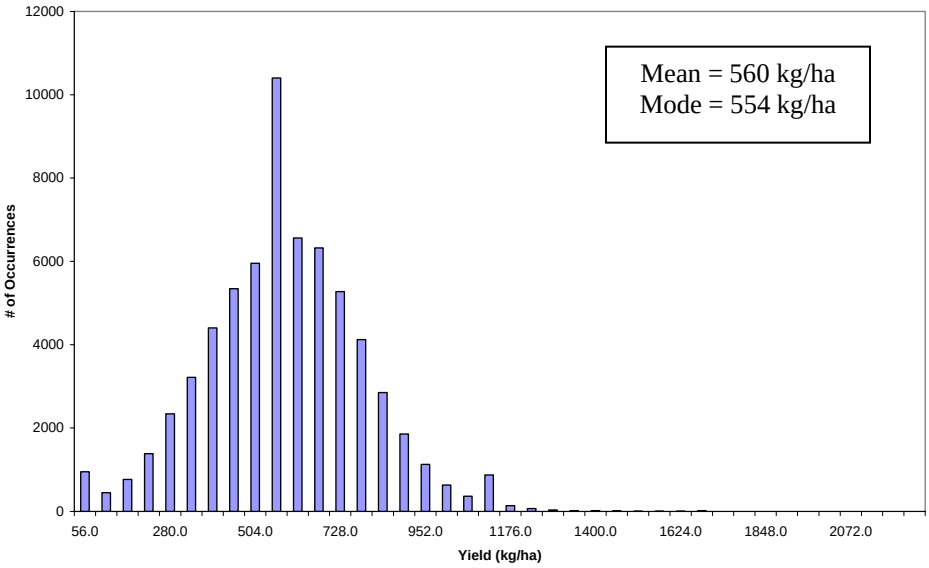

Figure 2. Distribution of cotton yield in field I1 during 2001 growing season.

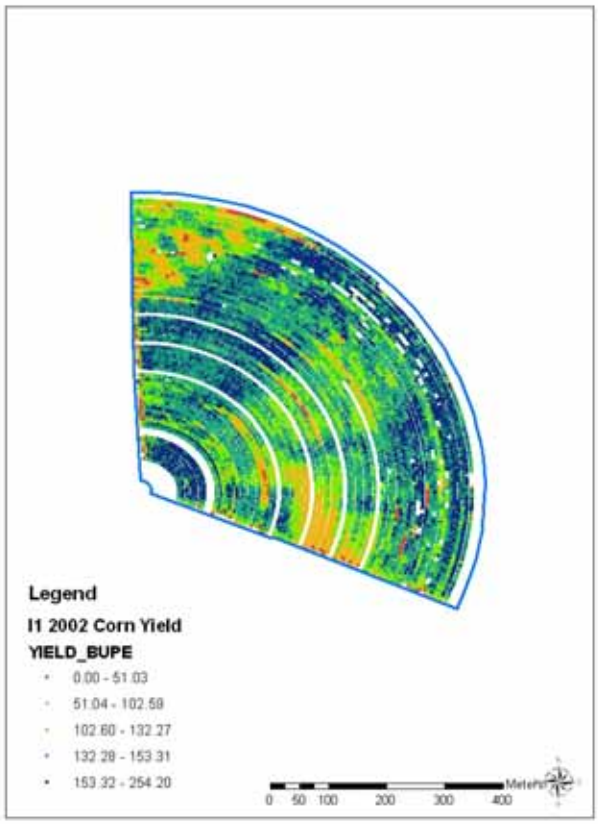

Figure 3. Grain yield for field I1 in 2002.

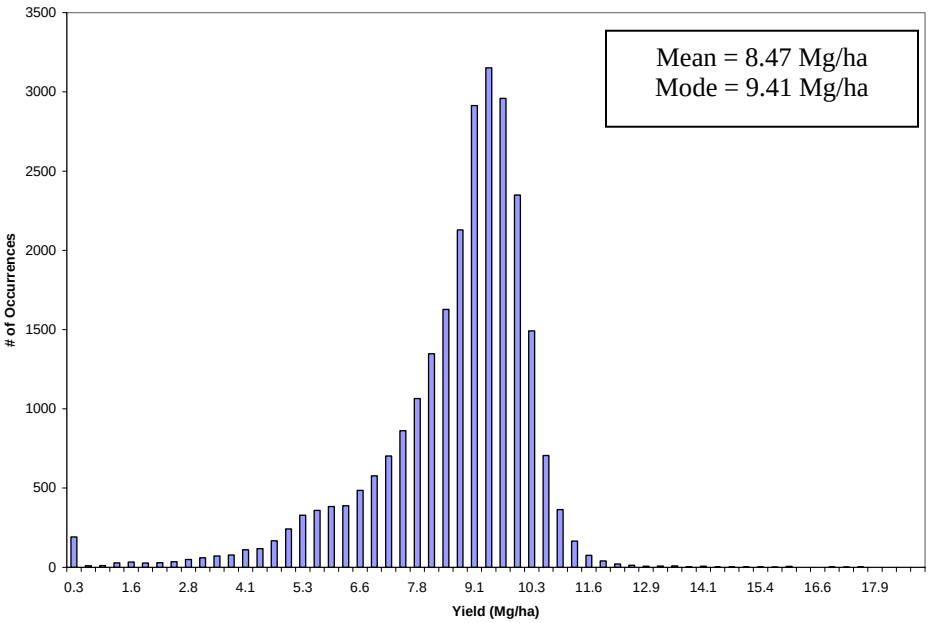

Figure 4. Distribution of grain yield in field I1 during 2002 growing season.

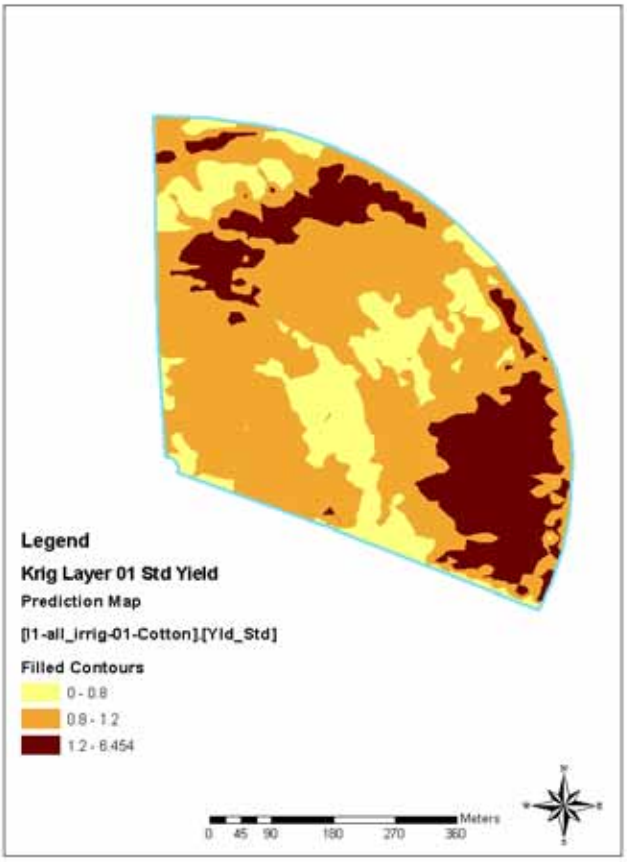

Figure 5. Interpolated surface of cotton yield in field I1 for 2001 growing season.

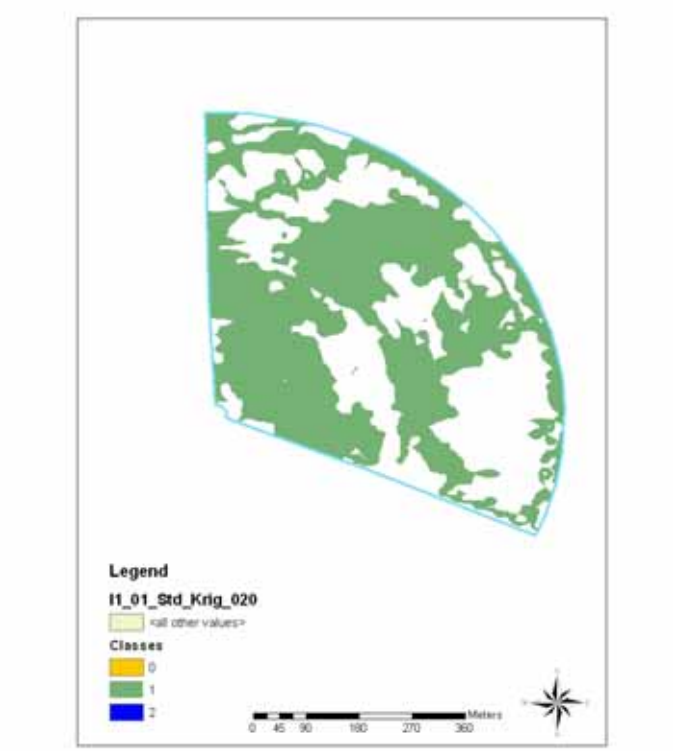

Figure 6. Average yield areas from interpolated surface of cotton yield in field I1 during 2001 growing season grouped by standardized mode +/- 20%.

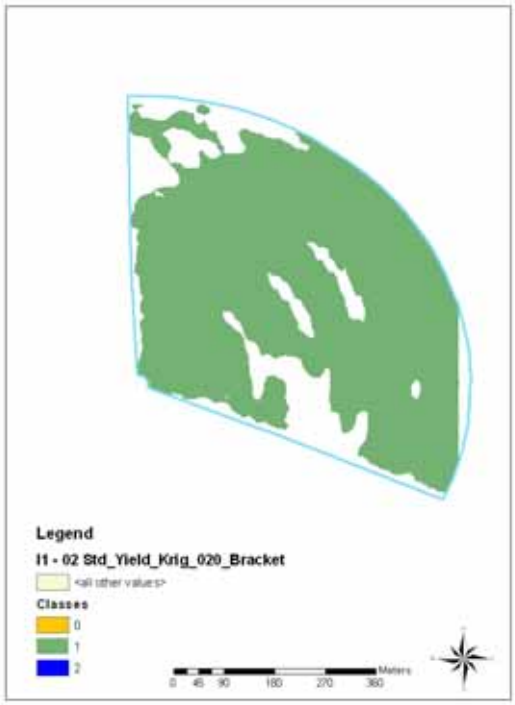

Figure 7. Average yield areas from interpolated surface of corn yield in field I1 during 2002 growing season grouped by standardized mode +/- 20%.

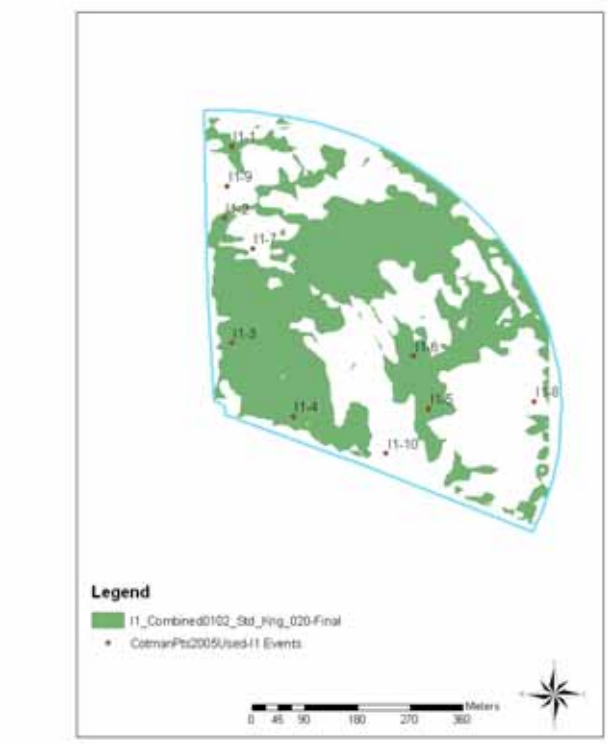

Figure 8. Geographic intersection of average yield areas from 2001 cotton yield and 2002 grain yield in field I1. Average yield areas were from interpolated yield maps grouped by standardized mode +/- 20%.

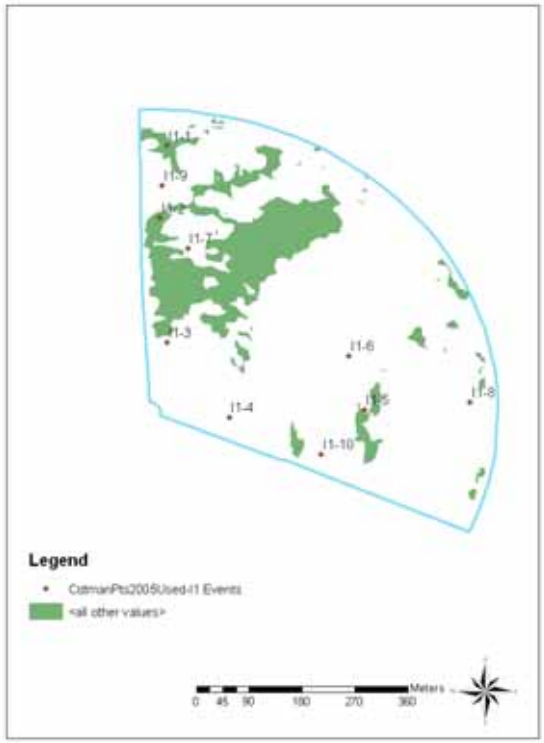

Figure 9. Geographic intersection of average yield areas from 2001 and 2003 cotton yield and 2002 and 2004 grain yield in field I1. Average yield areas were from interpolated yield maps grouped by standardized mode +/- 20%.

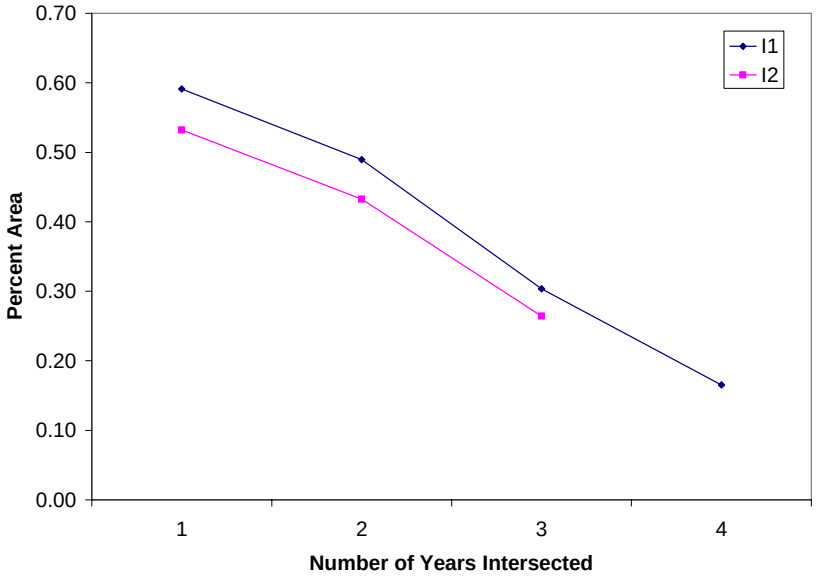

Figure 10. Percentage of field in average yielding areas as years of yield data are intersected together.

The identification of average yielding portions of the field was used as a basis for selecting COTMAN sampling points for the 2005 growing season. The point locations selected are shown on the average areas on both figures 8 and 9. In addition to points in the average yield field areas, points were selected in field areas that were classified as high and other yielding. COTMAN development curves for the most extreme development curves from pairs of points from the two year average yielding areas (figure 8) are in figure 11. The peak value for curves based on pairs of points on figure 11 has a range of +3.96/-2.24 nodes from the peak based on all the field points (table 3). The range in physiological cutout (NAWF=5) dates varies from +4.36/-8.70 days from the cutout based on all the field points.

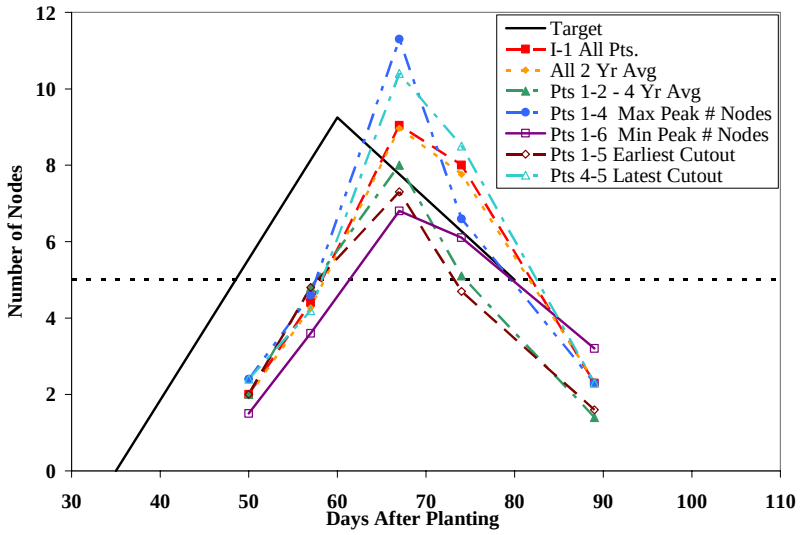

Figure 11. COTMAN development curves for sampling points in field I-1 for 2005 growing season. Curves are grouped by all points, and pairs of points in the average yielding areas of the field.

Table 3 Ranges in difference peak nodes and physiological cutout (NAWF=5) between curves from pairs of sampling points and all points in the field.

	Range in maximum peak for curves from paired points in average yielding areas as compared with curves from all sampled points	Range in cutout for curves from paired points in average yielding areas as compared with curves from all sampled points
I1	+3.96/-2.24	+4.36/-8.70
I2	0.62/-0.88	+0.83/-1.67
D3/D4	+5.13/-2.68	+2.40/-4.45
Arkansas	+0.93/-0.47	+4.46/-3.31

Tests of the COTMAN point selection procedure were also made with fields I2 and D3/D4 at the Burleson County site and the Arkansas site. Areas for COTMAN point selection were created from three years of yield data for field I2, two years for field D4 and one year of data for both fields D3 and the Arkansas data. Figure 12 shows a map of intersected average yield areas for field I2. Previously selected sampling points (Geiger and Searcy 2003) are also shown on this map. Five of the ten points fell in areas considered average yielding based on the historic yield maps. COTMAN development curves for the overall field and selected pairs of points are shown in figure 13. Large differences exist in the magnitude and day of the peak number of nodes. The day that physiological cutout (NAWF=5) occurs on has much less variability for this field than field I1 (table 3).

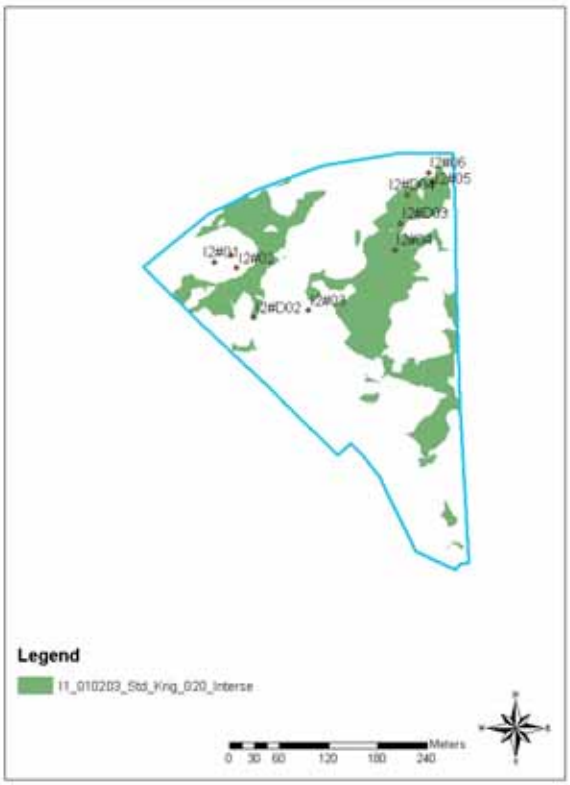

Figure 12. Geographic intersection of average yield areas from 2001, 2002 and 2003 yield in field I2. Average yield areas were from interpolated yield maps of yield.

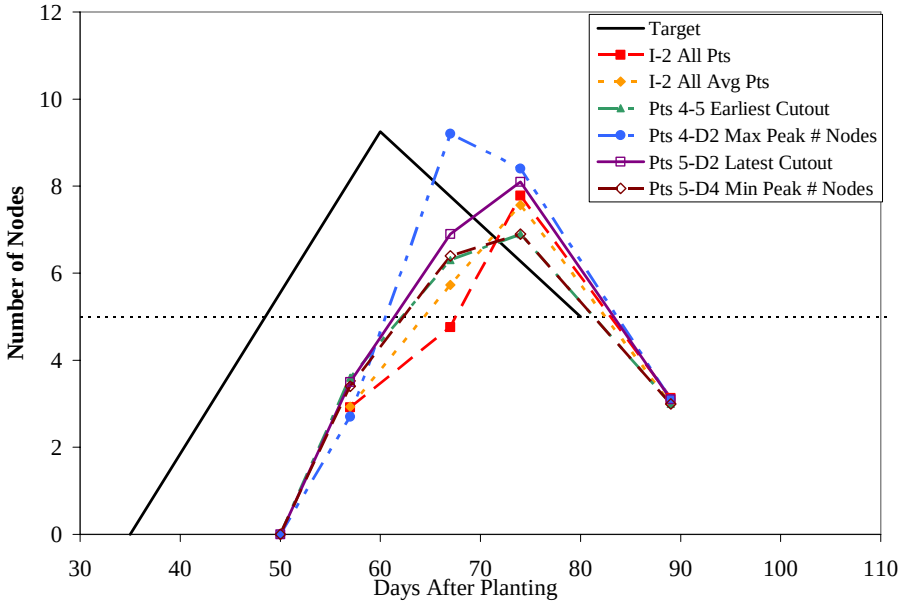

Figure 13. COTMAN development curves for sampling points in field I2 for 2005 growing season. Curves are grouped by all points, and pairs of points in the average yielding areas of the field.

Average yield areas for field D3/D4 and the Arkansas field are shown in figures 14 and 16, respectively. COTMAN development curves for these two fields are shown in figures 15 and 17. Only two sampling points appear in the green average yielding area on figure 14 because the points were originally selected using different class ranges than shown here. The map of average yielding areas for the Arkansas data set is unique because a much larger portion of the field is classified as average yielding as compared to the maps from Burleson County. The Arkansas site was classified with only one year of yield data, therefore adding more years of yield data would decrease the amount of the field classified as average yielding. Trends in peak nodes and timing of cutout were similar to those observed for field I1 with large variations in both parameters.

Figure 14. Geographic intersection of average yield areas from 2002 yield and 2004 yield in field D4 and average yield areas from 2004 in field D3. Average yield areas were from interpolated yield maps of yield.

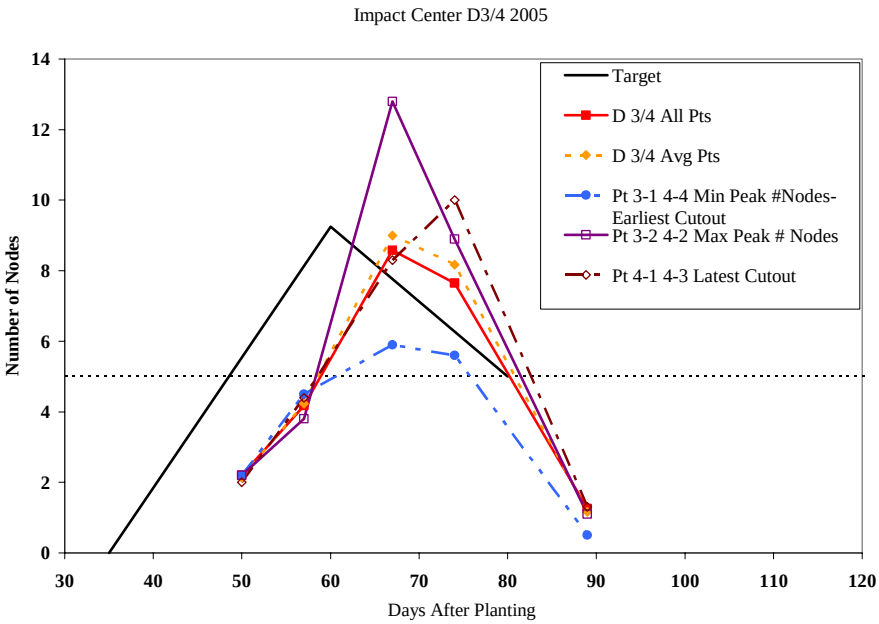

Figure 15. COTMAN development curves for sampling points in field D4 for 2005 growing season. Curves are grouped by all points, and pairs of points in the average yielding areas of the field.

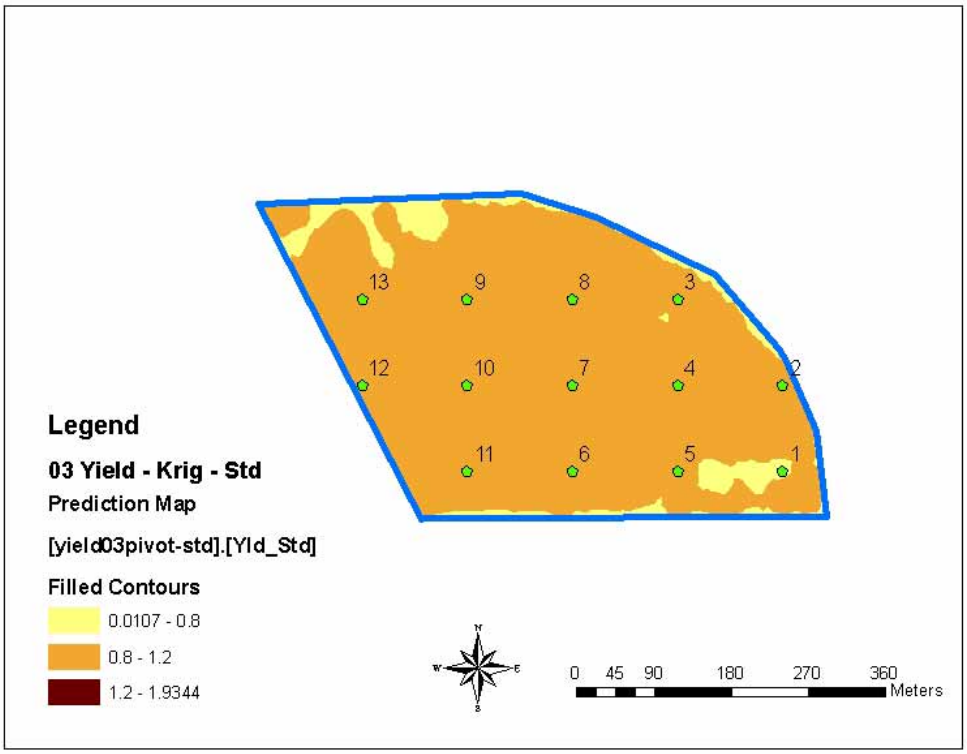

Figure 16. Average yield areas from interpolated surface of cotton yield at Marianna Arkansas site during 2003 growing season grouped by standardized mode +/- 20%.

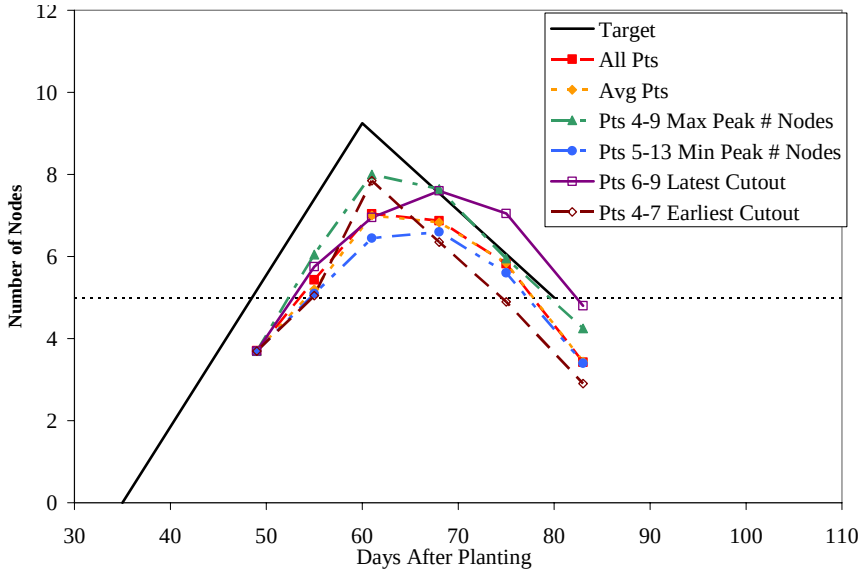

Figure 17. COTMAN development curves for sampling points at Marianna Arkansas site for 2003 growing season. Curves are grouped by all points, and pairs of points in the average yielding areas of the field.

Summary

Average yielding areas from multiple growing seasons were combined to select locations of COTMAN sampling points. In this analysis, the mode of the grain data sets appeared to represent the central tendency of the data better than the mean. COTMAN development curves from pairs of sampling points from the selected average areas in the 2005 growing season showed wider variation than expected. Using additional years of data in the point selection process would narrow the areas to select from and potentially the range of results obtained with COTMAN.

Acknowledgements

Funding for this project was through a grant from Cotton, Inc. The Arkansas data was provided by Leo Espinoza of the University of Arkansas.

References

Benson, N. R., M. J. Cochran, G. L. Smith. 2000. Benefits of Cotman – Consultant's Perspective. Proceedings of the 2000 Cotton Research Meeting and Summaries of Research in Progress. University of Arkansas Agricultural Experiment Station Special Report 198:44-47.

Geiger, D. W., S. W. Searcy and D. D. Fromme. 2004. Precision agriculture: A tool for COTMAN. Proceedings of the 2004 Beltwide Cotton Conferences, San Antonio, Texas, January 5-9 2004., pp. 700-709.