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APPLICATION OF SITE-SPECIFIC DATA IN COTTON PRODUCTION PRACTICES

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Abstract

Crop management practices have generally been applied to entire cotton fields or farms. Recently, precision agricultural technologies have been adapted to detect intra-field variability of plant development and yield. Several tools including global positioning systems (GPS), geographical information systems (GIS), remote sensing technologies, and yield monitors are available and can provide considerable information on which to base production decisions. The value of this information is directly related to the ability to examine areas within fields and have knowledge of the specific location of those areas. Producers can use this information to define zones within fields that exhibit yield-limiting problems. These same technologies can then be used as components in a system to apply site-specific solutions (fertilizers, pesticides, drainage, irrigation, etc.) and correct or reduce the impact of those problems. Precision agricultural technologies have the potential to reduce input costs, increase yields, and improve the efficiency of cotton production in the United States.

Introduction

The efficiency and profitability of cotton production in the U.S. is rapidly improving due to advances in genetics, integrated pest management (IPM), and engineering technologies. Until recently, the ability to integrate novel production strategies was limited to application across whole fields or farms. All production inputs recommended for a field were based upon the average of the deficiencies as determined by a sampling system for the whole field. In addition, the post-treatment evaluation and ultimate changes in yield also were based upon an average of data collected across the entire field. Geospatial and precision (site-specific) technologies are currently available to detect and manage production problems that vary spatially and temporally within fields (Pierce and Nowak 1999). This information allows producers to manage specific areas that express different needs and production levels. Application of site-specific inputs can improve the efficiency and value of production strategies.

The full potential of precision agricultural technologies will not be realized until all segments of the cotton industry become confident in this technology and recognize the value of site-specific management. Considerable cooperation among producers, agricultural consultants, and commercial pesticide applicators will be necessary for the ultimate success of the technology (Fig. 1). The purpose of this report is to provide a few examples on the applicability of site specific information in cotton production.

Farm Geography and Historical Records

The initial application of global positioning systems (GPS) and geographical information systems (GIS) to the cotton industry was to develop detailed maps of field and farm boundaries with specific acreages. The acquisition of site-specific data requires mapping the field borders to provide a base map. Satellite imagery, aerial photography, and harvest data can be used to provide layers of data that are geo-referenced over the base image or map. One such application is the use of geo-referenced yield maps that can accurately describe the contribution of various field areas to total yield for the entire field. The utility of the data in developing images that describe specific intra-and inter-field variation has not been fully exploited because of the complexity of data management. At a minimum, the collection of site-specific information across a farm provides a historical perspective that crop managers can use to reference all future comparisons relative to crop inputs and yields.

Detection of Agronomic Problems/Soil Management

GPS and GIS are powerful tools in detecting problems limiting yields both within fields and across farms. Satellite images, aerial photography, soils maps, and DOQQ's can provide information to detect production problems and improve management strategies. In many instances, these data are public information and can be obtained as electronic files from state and federal sources. Although, this information is usually considered to be relatively coarse, the data can estimate geographical attributes across large areas.

More specific data about field variability can be from obtained yield monitors, SEM tools (Veris and EM sensors), and high resolution cameras on satellite or aircraft-based platforms. Maps based on any number of variables (soil characteristics, elevation and drainage, plant development, yield, etc.) that accurately delineate different zones within a field can be developed using these data. These maps can then be used to identify site-specific crop yield or income limiting problems within a field and assist producers in making informed decisions about management solutions.

Pest Detection and Sampling

GPS is becoming an important tool to cotton scouts and crop managers in detecting pests and defining those locations in cotton fields. Incorporating these sample data into GIS provides an accurate geo-referenced view of the pest problems in fields. These data become an historical record of "hot spots" and also document the exact sites to be evaluated on consecutive scouting dates.

Some insect pests can be temporally associated with intra-field variation in plant growth recorded by "remotely sensed data" and visually demonstrated on maps. The foundation of an IPM strategy in cotton is based on information from sampling protocols. Therefore, site-specific technologies should improve the accuracy of information used to develop management tactics for insects and other pest problems.

Plant Growth Regulators/Harvest Aids

Currently, the most effective demonstration of site-specific data is to describe intra-field variation of plant growth and crop maturity. Detection and management of defined zones within fields that demonstrate excessive plant growth has been successfully accomplished with site-specific data obtained from remote sensing sources. Late-season images also can be used to demonstrate intra-field variation in crop maturity as it relates to the application of harvest aids.

Prescription (Site-Specific) Application of Crop Production

Precision agricultural technologies using site-specific data can allow producers to apply crop inputs to specific zones within fields rather than applying broadcast treatments to the entire field. Although site-specific fertilizer and pesticide application technologies are not common in southern row crop production systems, their value has been recognized. GPS and GIS tools are now available to provide a geo-referenced identity of the target zone and to transfer the local coordinates of the zone to the individual capable of managing the problems.

The basis for prescription applications is supported by the concept of IPM. Zones within a field that do not have pest levels above economic thresholds should not receive crop protection inputs. In addition, those zones that are not capable of producing profitable yields due to an unidentified limiting factor are not likely to respond with yield increases from additional unnecessary inputs. Without site-specific information to define those zones, the entire field would be treated as a single unit based on data averaged across the whole field.

After identifying and precisely locating a field zone associated with a management problem, site-specific application technologies are required to take corrective action. The application of site-specific management strategies requires equipment that has been adapted for prescription treatments. Hardware and software components comprising such a system are complicated, but site-specific application technology is improving at an accelerated rate. This equipment must be equipped with a combination of GPS and GIS technologies that can use data defining individual zones within fields. These data are used to generate prescription-based maps that allow variable-rate application of crop production inputs. These inputs are applied only at the rates required to those specific zones that are capable of providing positive economic returns.

Summary

The benefits of site-specific data and prescription application technologies can be realized at several levels in cotton farming enterprises. The overall net return on crop value will be enhanced by improving the efficiency of crop production practices. Crop managers can use site-specific data in combination with GPS/GIS tools to improve their ability to sample, detect, and record yield-limiting problems within fields. Production costs can be mediated by using variable rate technologies in prescription applications with sufficient science-based data to support recommendations. The availability of site-specific data and associated tools to use this information for cotton production can result in more efficient crop monitoring procedures, reduced crop production inputs, and better utilization of environmental resources.

References

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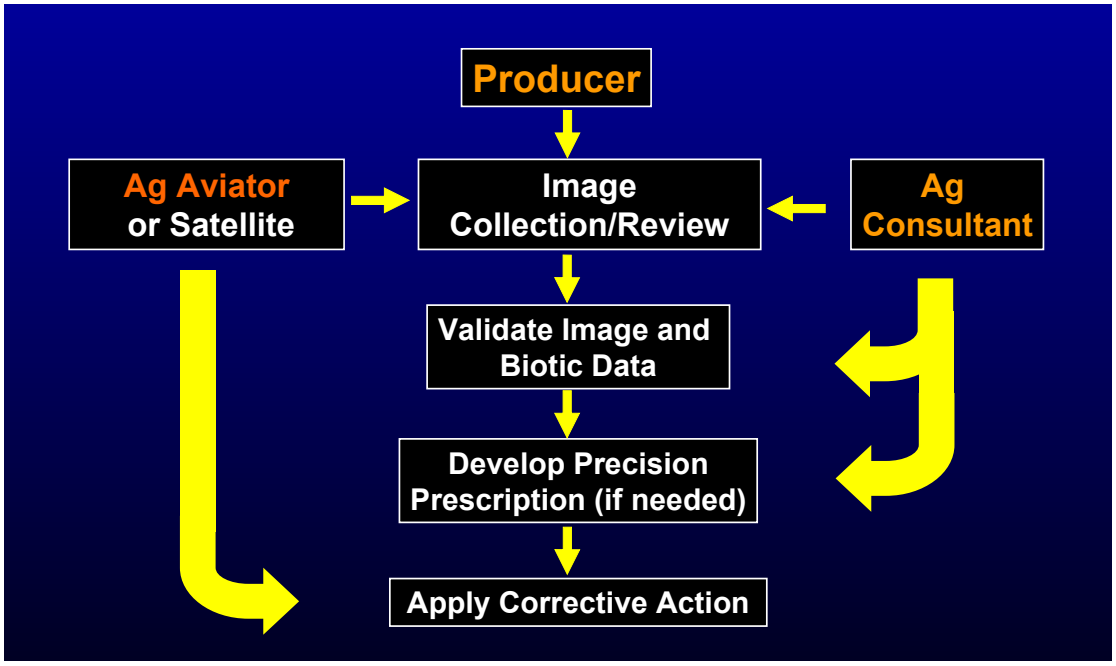

Figure 1. Site-specific technology application model for the cotton industry.