PRECISION AGRICULTURE EDUCATION PROGRAM IN NEBRASKA

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ABSTRACT

With the cost of agricultural inputs and the instability of commodity prices increasing, demand is growing for training in the essential skills needed to successfully implement site-specific crop management. This set of skills is uniquely interdisciplinary in nature. Thus, it is essential for potential users of precision agriculture to understand the basics of geodetic and electronic control equipment, principles of geographic information systems, fundamentals of geostatistics and production economics, elements of soil fertility and other aspects of crop production, and logistics of modern farming operations. Our core undergraduate course is called *Site-Specific Crop Management* and is cross-listed under the Agronomy, Mechanized Systems Management, and Agricultural Engineering majors. In addition, we teach a graduate distance education course on spatial variability in soils. This paper outlines major challenges and solutions regarding the interdisciplinary nature of precision agriculture education.

Keywords: site-specific crop management, education, undergraduate course

INTRODUCTION

According to the National Research Council (Sonka et al, 1997), “precision agriculture is a management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production.” Although information-based field management remains important, precision agriculture has stimulated the adoption of automatic guidance, telemetry, precision livestock management, product traceability, and other technologies that go beyond the initial concepts of site-specific crop management (Gebbers and Adamchuk, 2010). In fact, these new practices frequently overshadow the original idea of varying agricultural inputs according to local needs, while pursuing the same three basic objectives: 1) to increase agricultural production efficiency; 2) to

reduce negative environmental impact; and 3) to improve social aspects of modern farming (Pierce and Nowak, 1999). During the last twenty years, precision agriculture has been extensively explored by producers, agribusinesses, the equipment industry and, certainly, academia. The continuous change in precision agriculture technologies and the rapid evolution of relevant products have driven educational programs to be dynamic in nature.

The objective of this publication is to review the precision agriculture education program offered at the University of Nebraska-Lincoln and share some pros and cons of our present teaching experience in this area.

COURSE OVERVIEW

The University of Nebraska-Lincoln *Site-Specific Crop Management* course has been offered to junior and senior students in Agronomy, Mechanized Systems Management, and Agricultural Engineering majors (AGRO/MSYM/AGEN 431). This elective course has provided an opportunity for students from these majors to work together while acquiring credit in their own majors. The course was developed to provide an overview of the principles and concepts of precision agriculture. It focuses on hands-on experience using hardware/software and information management systems for mastering the essential steps when adopting site-specific crop management. It is offered each fall semester and features two lectures and one laboratory activity each week.

The course objectives are for the student to:

1. Use global navigation satellite systems (GNSS) receivers and understand the meaning of geo-referenced data.
2. Use geographic information systems (GIS) software to accomplish primary spatial data management tasks.
3. Work with yield monitoring and other relevant data acquisition equipment.
4. Identify major sources of errors and develop proper data-handling strategies.
5. Determine the potential usage of remote sensing and automated on-the-go mapping systems.
6. Understand the principles of variable rate application of seeds, water, fertilizers, lime, and other chemicals.
7. Integrate yield and soil fertility maps with other geo-referenced data to develop an effective site-specific crop management program.
8. Apply a systems approach and common sense to deduct causes of spatial variability and develop corresponding recommendations.
9. Identify potential advantages (both economic and environmental) and current limitations of precision agriculture.

To accomplish these goals, the course has been divided into two parts. In the first half of the course, students are introduced to the various technologies involved in precision agriculture. Students work in teams on projects throughout the course, with the first project aimed at gathering information on equipment available to Nebraska producers that could be used to start precision agriculture practices in a traditional Midwestern farm. The second half of the semester is dedicated to agronomic analysis of site-specific crop information. At the end of the semester, teams develop site-specific management plans for several Nebraska production fields offered as case studies.

During laboratory sessions, students engage in field data collection (geotracking as well as yield and soil mapping); visit the annual Husker Harvest Days farm show; discuss practical aspects of precision agriculture with a panel consisting of local practitioners (typically a farmer, a crop consultant, and an agribusiness representative); present their projects to the rest of the class; and work extensively in a computer lab. For the computer lab exercises, students have used commercial GIS software packages including AgInfo (Agronomy Service Bureau, Oran, Missouri), ArcView (ESRI, Redlands, California), FarmWorks (CTN Data Services Inc. Hamilton, Indiana), AGIS (Delta Data Systems, Inc., Picayune, Mississippi), SMS (AgLeader Technology, Inc., Ames, Iowa), and Manifold (Manifold Net Ltd., Carson City, Nevada).

Lowenberg-DeBoer (2000), Morgan and Ess (2003) as well as Precision Agriculture series of extension circulars (University of Nebraska Extension, Lincoln, Nebraska[1]) have been used as primary reading references for the course. The course syllabus, lecture handouts, and other materials relevant to this course can be viewed at: *http://bse.unl.edu/adamchuk/class_ssm.*

COURSE ANALYSIS

The number of students enrolled in the course has changed from year to year, as has the majors represented (Figure 1). Although the majority of students taking the course were from Agronomy and Mechanized Systems Management majors, a significant number of Agricultural Engineering and Diversified Agriculture students have taken the course as well. Other students were majoring in Agricultural Economics, Agribusiness and Agricultural Education. Due to the size of the computer classroom and field trip vehicles, course enrollment has been limited to 22 students (15 in some years).

Most of the students (92%) registered for the course had some farming background in their family operations. However, students' levels of prior experience in terms of computer and precision agriculture-related skills have changed from year to year (Figure 2). It is most noticeable that in recent years a greater percentage of students taking the course have had some practical experience working with tools discussed during the course. This definitely caused some differences in course evaluations and in average scores of individual class activities (Figure 3). It appears that the students enjoyed hands-on experience when collecting field data and communicating with representatives of precision agriculture equipment companies during the annual Husker Harvest Days farm show. On the other hand, some of the statistical and geostatistical methods lectures had the lowest ratings.

Based on this annual evaluation, the course flow has been modified each year. Some purely theoretical topics have been blended with more pragmatic concepts to get students involved in the practical aspects of precision agriculture adoption. For example, some statistical principles are now combined with geospatial data processing discussions instead of being presented as individual lecture topics.

The teamwork activities emphasized during the course must be highlighted. Since the course is offered during the last year of education to students from

[1] Downloadable at: *http://cropwatch.unl.edu/web/ssm/home*

different majors, this creates a unique opportunity to work in teams representing different disciplines. To some extent, this replicates an actual agribusiness work environment in which individuals with technical backgrounds rely on assistance from agricultural and economics experts to implement new management strategies.

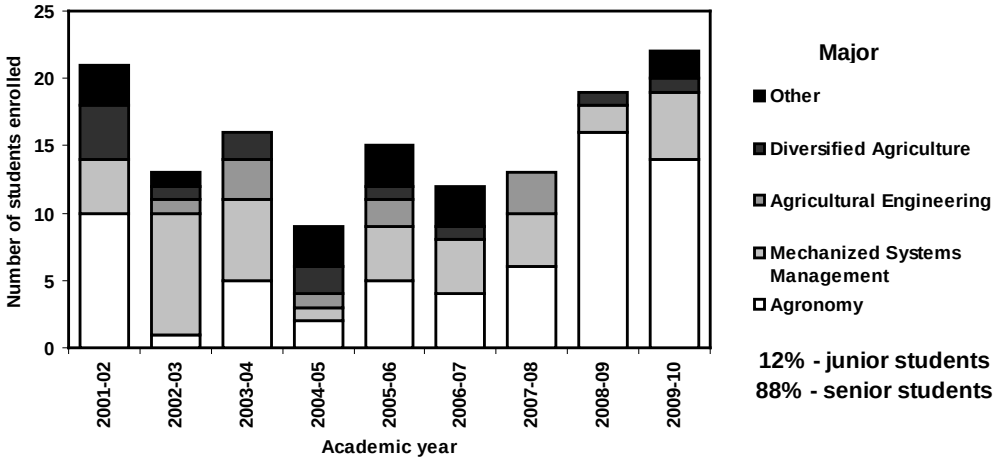

Figure 1. Number of students enrolled in site-specific crop management course.

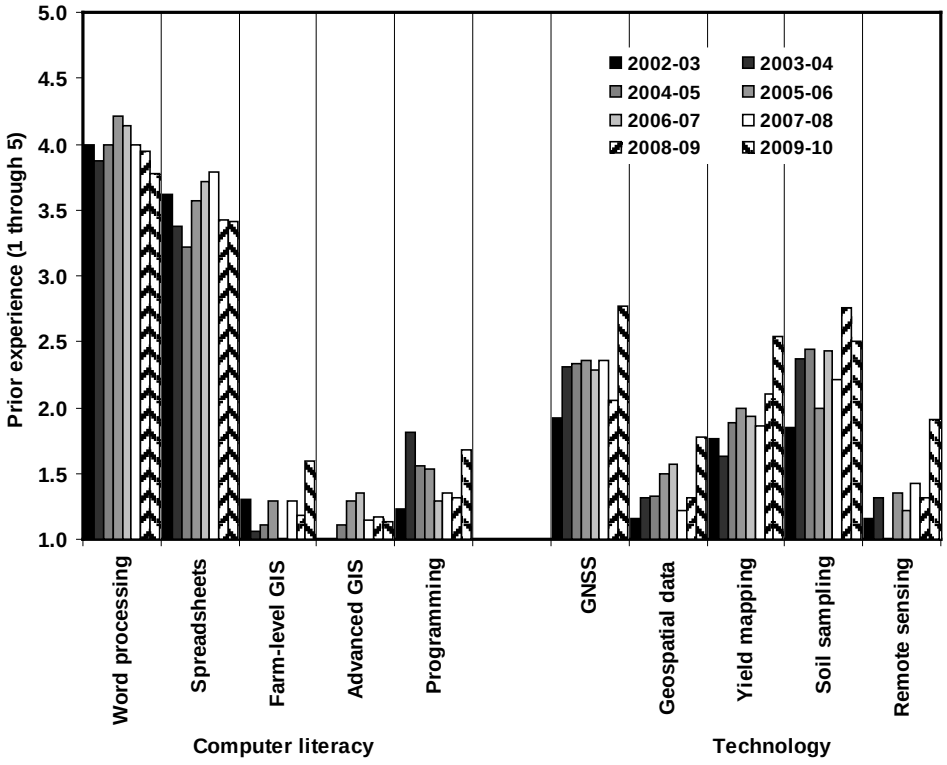

Figure 2. Background of students taking site-specific crop management course.

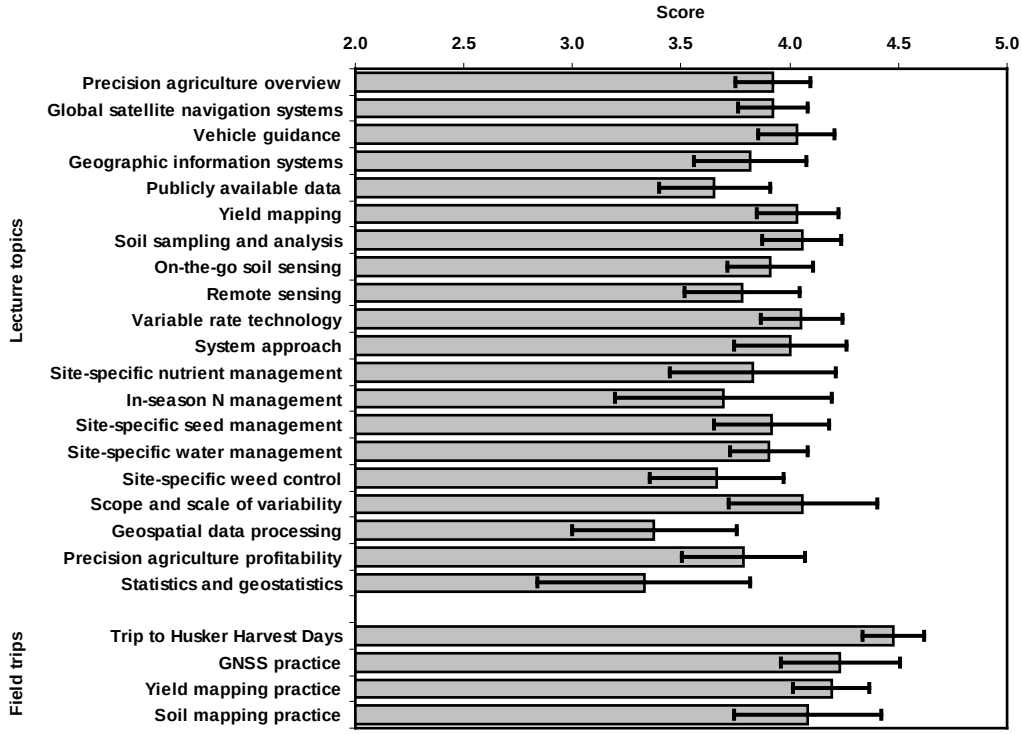

Figure 3. Student scores (average and standard deviation on a 1 to 5 scale) for different course activities.

THE NEXT STEP

The University of Nebraska-Lincoln *Site-Specific Crop Management* course is aimed at undergraduate education. There are other courses offered at the University in the areas of geographic information systems, agricultural production systems management, mechanized equipment, and statistics that address the various skills needed for successful implementation of precision agriculture practices.

Also, relevant course work has been developed for graduate and distance education students. *Spatial Variability in Soils* (AGRO 831) has been the most notable course offered during the spring semester of even-numbered calendar years. This course examines the basic concepts of soil spatial variability – its underlying causes as well as what impacts variability has on management, primarily for crop production. Students become familiar with geographic and geostatistical concepts used in describing and measuring spatial variability. Learners are introduced to approaches to the use of spatial information for more profitable crop production.

Finally, University of Nebraska Extension workshops and the annual Nebraska Agricultural Technology Association (NeATA) conference have become the primary means of education for practitioners involved in precision agriculture around the state. Once students have engaged in relevant education activities, they are more inclined to watch for new technologies in precision agriculture and to continue learning. One of the most important University missions is to assist in this lifelong learning process.

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