ASAE Annual International Meeting
July 17, 2005

Teaching Precision Agriculture Concepts
(UNL Program)

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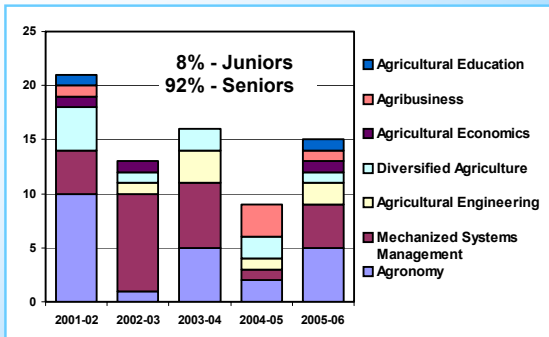
Course Description

- Title: **Site-Specific Crop Management**
- Offering: Fall semester – 3 credit hours (2 hrs lecture and 3 hrs lab) - elective
- Prerequisites: Senior standing with previous introduction to soils and/or general agriculture
- Cross listing: Agronomy, Mechanized Systems Management and Agricultural Engineering majors
- Instruction: Co-taught between Biological Systems Engineering and Agronomy and Horticulture (Dr. Richard Waldren) Departments with several guest speakers
- Description: Principles and concepts of site-specific management. Evaluation of geographic information systems for crop production practices. Practical experience with hardware and software necessary for successful application of information affecting crop management.

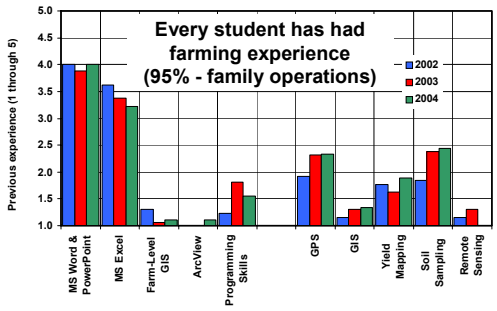
Course Objectives

1. Use global positioning system (GPS) receivers and understand the meaning of the geo-referenced data
2. Use geographic information systems (GIS) software to accomplish primary 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 potential usages for remote sensing and automated on-the-go measurement systems
6. Understand the principles of variable rate application of seeds, water, fertilizers, lime, and pesticides
7. Integrate yield and soil nutrient maps with other geo-referenced data to develop an effective site-specific crop management program
8. Apply a system approach and common sense to deduct the causes of spatial variation and develop corresponding recommendations
9. Identify potential advantages (both economic and environmental) and current limitations of site-specific crop management

Enrollment



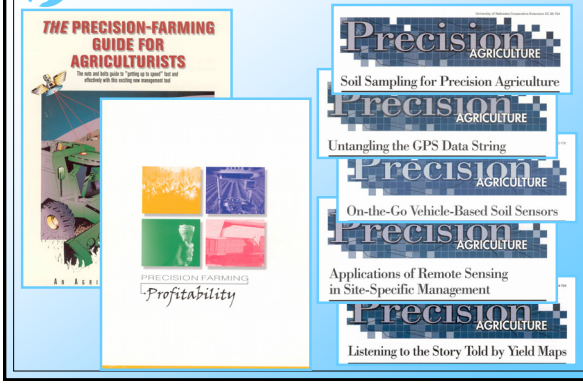
Relevant Background



General Topics

- History and present level of Precision Agriculture
- Principles of yield mapping
- Principles of Global Positioning System (GPS)
- GPS vehicle guidance
- Principles of Geographic Information Systems (GIS)
- Web-based data layers
- Methods for soil sampling and analysis
- On-the-go soil & plant sensors
- Site-specific nutrients and water management
- Introduction to remote sensing
- Interpolation and processing of georeferenced data
- Statistical/geostatistical tools
- System approach to improved management strategies
- Variable rate technology

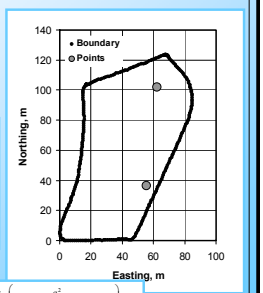
Textbooks



Hand-on Experience

- Field trips
  - GPS field practice
  - Yield mapping practice
  - Soil pH/EC mapping and sampling practice
  - Husker Harvest Day visit
- Laboratory
  - Yield monitor and lightbar guidance displays
  - GPS data interpretation (MapSource)
  - From basic data to prescription maps (AgLeader SMS Advanced)
  - Profitability of precision agriculture (EXCEL)

GPS Practice



Tracking (boundary)

Measurements (distance)

Navigation (hide and find)

$$F_{lon} = \frac{\pi}{180}\left(\frac{a^2}{\sqrt{a^2\cos^2\varphi + b^2\sin^2\varphi}} + h\right)\cos\varphi$$

$$F_{lat} = \frac{\pi}{180}\left(\frac{a^2 b^2}{\sqrt{\left(a^2\cos^2\varphi + b^2\sin^2\varphi\right)^3}} + h\right)$$

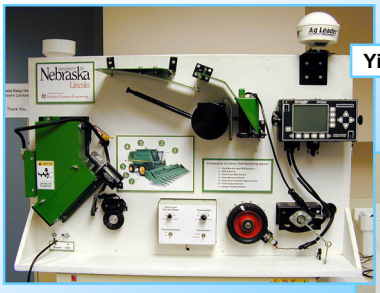
Field Mapping Practice

Yield monitor installation, calibration, and operation

On-the-go mapping of soil pH and electrical conductivity

Soil sampling

Functional Displays



Yield Monitor

Lightbar Guidance

Knowledge Assessment

- Assignments
  - Spreadsheet assignments (GPS and yield data, profitability)
  - Spatial data importing and display
  - Yield history analysis
  - Development of prescription maps
- Two term projects
  - Technology – recommended line of equipment
  - Applications – case studies
- Two written tests

Case Studies

- Three locations
  - Clay Center, NE (160 acres)
  - Cairo, NE (160 acres)
  - Bellwood, NE (200 acres)
- Principle data
  - Field boundary (.shp)
  - Six-seven years of crop yield (.txt)
  - Field topography (.txt)
  - DOQ image (.jpg)
  - Soil map (.shp)
  - Electrical conductivity measurements (.txt)
  - Soil laboratory analysis – 1 acre sampling (.txt)
  - Soil texture analysis – 3 acre sampling (.txt)

- Center pivot irrigation
- Ridge tillage
- Continuous corn (soybean enclosures)

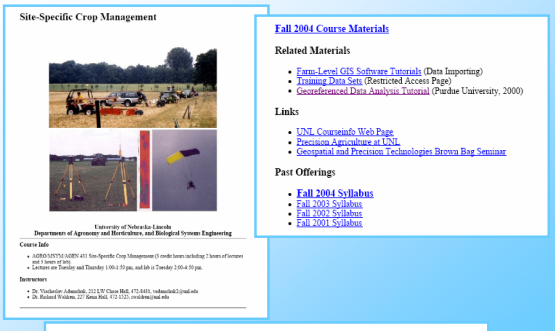
Topic and Activity Ranking

Hands-on activities

"Difficult" topics

Topic/Activity	Rank	Improvements
Husker Harvest Days Trip	1	10
GPS Practice	2	21
Yield Monitor Display Exercise and Lab Tour	3	14
Yield Mapping Practice	4	13
Soil Sampling Practice	5	20
Analyzing Yield and EC Maps	6	16
Site-Specific Water Management	7	12
Principles of GPS	8	6
Yield Mapping	9	3
Variable Rate Technology	10	7
Variable Rate Planting	11	5
GPS Vehicle Guidance	12	17
Soil Sampling and Analysis	13	22
Principles of GIS	14	2
On-the-Go Soil Sensors	15	4
Light Bar Demonstration	16	N/A
History of Precision Agriculture	17	19
Precision Agriculture Profitability	18	18
Soil Nutrients Management	19	1
Introduction to Remote Sensing	20	15
Approaches to Problem Solving	21	8
Optical Weed Sensors	22	11
We-Based Data Layers	23	24
On-farm Research	24	N/A
Statistical and Geostatistical Tools	25	23
Interpolation and Data Processing	26	9
Plant Sensors	27	N/A

Course Website



http://bse.unl.edu/adamchuk/class_ssm

Graduate Level Course

- Title: Mechanized Agricultural Systems / **Precision Agriculture Advances**
- Offering: 3 credits – fall semester (odd-numbered calendar years)
- Description: Advanced concepts of equipment used in agriculture with emphasis on site-specific management (precision agriculture). Focuses on hardware development and information technologies applied to generic agricultural production

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Teaching Precision Agriculture Concepts

(Survey Results)

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Biological Systems Engineering
University of Nebraska - Lincoln

Nebraska

Questions

- Who are the instructors?
- Whom do we teach?
- What do we teach?
- How do we teach?
- What can be improved?

Scope of the Survey

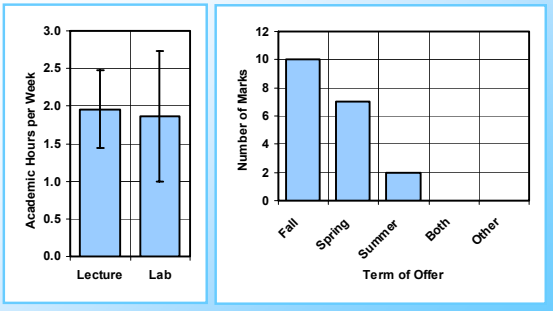
- 18 completed course survey forms have been submitted
- These forms reported on 19 different courses (17 different major instructors)
- Universities from the following 14 states are represented:

✓ Alabama
✓ Colorado
✓ Florida
✓ Georgia
✓ Indiana
✓ Kansas
✓ Michigan
✓ Minnesota
✓ North Carolina
✓ Nebraska
✓ South Dakota
✓ Tennessee
✓ Texas
✓ Washington

Course Titles

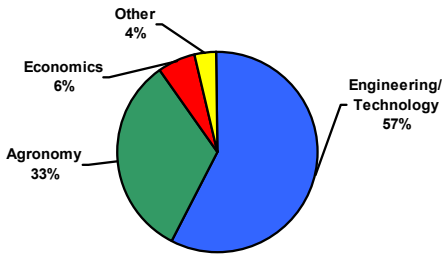
- Principles of Precision Agriculture
- Introduction to Precision Agriculture
- Precision Agriculture Technologies
- Crop Production with Precision Farming
- Agricultural Precision Systems
- Site Specific Management
- Site-Specific Crop Management
- Using GIS in Production Agriculture
- GIS in Agriculture
- GIS/GPS Applications to Biosystems
- Spatial Technology for Precision Agriculture
- Advanced Precision Agriculture

General Course Info

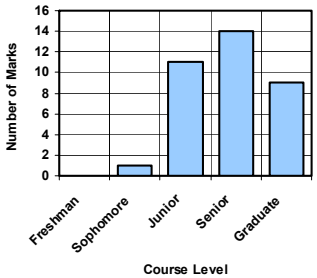


Every reported course represents 3 credit hours (lectures and labs)

Teaching Effort



General Student Info



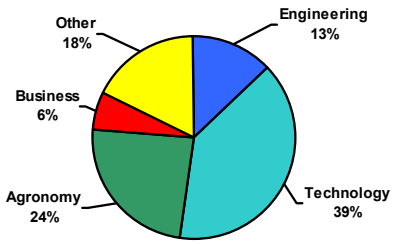
Total number of students reported:

- 2001-02 – 199
- 2002-03 – 259
- 2003-04 – 281

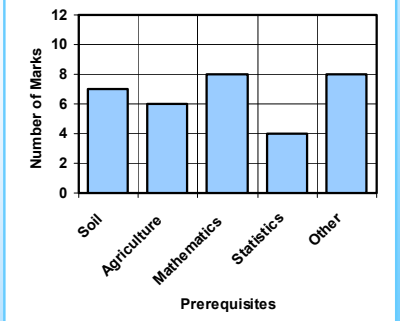
Class size:

- Average – 16
- CV – 44%
- Min – 3 (G)
- 8 (U)
- Max – 27 (37)

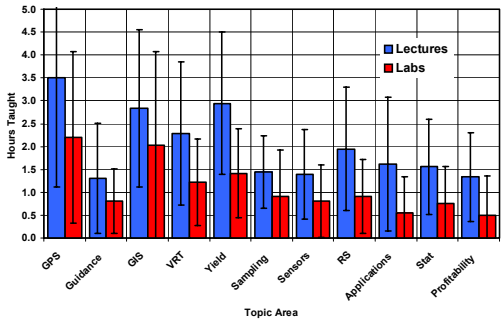
Student Majors



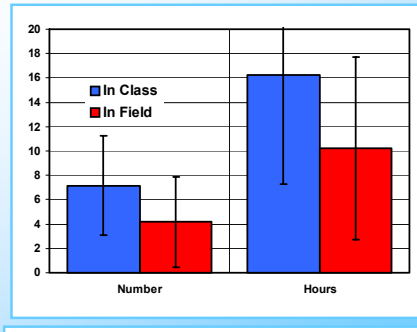
Prerequisites



Major Topics



Laboratory Sessions



Some courses include trips to special events

GIS Software Used

Software	Number
ESRI (ArcView 3.x, ArcGIS 8.x)	7
SSToolbox	3
AgLeader (SMS Advanced)	3
FarmWorks	3
Surfer	2
Other (MapInfo, MapCalc, SGIS, JDOffice)	6

Discussion Issues

- Optimum course structure
- Majors involved
  - GIS applications vs. precision agriculture
- Sharing of training data
- Software diversity
- Textbook needs
- Open courseware
- What can/should be improved?