A Content Review of Precision Agriculture Courses Across the U.S.

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Abstract. *Knowledge of what precision agriculture (PA) content is currently taught across the United States will help build a better understanding for what PA instructors should incorporate into their classes in the future. The University of Missouri partnered with several universities throughout the nation on a USDA challenge grant. Precision Agriculture faculty from 24 colleges/universities from across the U.S. shared their PA content by sharing their syllabi from 43 different courses. The syllabi were searched for key topic phrases that identified the PA subject matter that was taught. Our review of the content showed a growing need for a more standardized curriculum, emphasizing the need for a better connection between industry needs and university faculty.*

Keywords. *Precision agriculture, PA, precision agriculture course content, precision agriculture syllabi, GPS, site specific crop management, GIS, variable rate, remote sensing, environment, crop*

sensing.

Introduction

There are constant changes, adaptations, and improvements to the technology and methods used to enable and understand Precision Agriculture (PA). These constant changes require that farmers consistently adopt continuing education information that can help them to understand new technology. Some examples of these continuing education opportunities include farm field days, farm tours (Heiniger et al. 2002), and online courses. In contrast, within college education there is an overwhelming lack of research related to content analysis of PA courses offered through a higher education setting. The fact that there are very high costs associated with PA and the time that it takes to learn and develop the skill sets needed to teach PA have greatly reduced the distribution of knowledge about PA across the country (Reichardt et al. 2009). Research indicates that the extent and quality of teacher education matter for the teacher's effectiveness in the classroom (Darling-Hammond 2000). Researchers have found that this is the case for content presented within PA courses throughout the nation. Industry is the driving force for stimulated product development and adoption, causing educators and researchers to look to industry for research and education about the technology (Kitchen et al. 2002). The importance of knowing what is being used in industry helps to identify trends and develop core, pertinent principles for PA courses across the nation. For this reason, we conducted an investigation to determine the PA content areas that are taught and the depth that these topic phrases are presented in the classroom.

A team of interested faculty representing eight universities throughout the nation, participated in a challenge grant funded by the USDA. Precision agriculture faculty from across the US were invited to share PA content found in their course syllabi. A total of 43 course syllabi were obtained (one syllabi being from Montreal, Canada). Prerequisites, both college core prerequisites and courses needed before enrolling in advanced PA courses were identified. One of the goals of this investigation was to determine the common PA topic phrases for courses. Through this effort there could be a similar or more unified PA language used in the college setting. The data that was reported in the syllabi varied greatly. Some syllabi had great detail while, other syllabi only contained general university syllabi information.

The objectives for this precision agriculture research were to:

1.) Gain a better understanding of the topics taught within precision agriculture courses by determining topics taught in entry and/or advanced level courses, and what phrases are used to address these topics.

2.) Gain insight about the level of detail used to teach precision agriculture to students attending colleges/universities.

Methods

The research team, led by the University of Missouri, first identified universities across the U.S. that were teaching PA. The universities that had PA programs or coursework were found through known colleagues and google searches. A letter and email were sent to these universities (Appendix A) to determine if they would be willing to share their course syllabi. It was reasoned that the syllabi would contain information about PA topics taught at each institution. In order to determine the specific content taught in each course (from the syllabi), a list of keywords and phrases were generated from the table of contents of a revised PA textbook under development by researchers working in PA. The goal was to create a list of topics by keywords and phrases that might be common among several precision agriculture instructors. The list was compiled using the table of contents that Kent Shannon (and others) had put together for the revised PA textbook. Once the list of potential precision agriculture programs were compiled an email was sent to each program chair. The University of Missouri requested a copy of all PA course syllabuses that were taught at their institution. The research team first sent out letters asking for syllabi beginning in August 2015. A second reminder email was sent to the entire list of participants again the latter part of August 2015. Once the

University had received copies of the syllabi they were saved as a searchable PDF. If hard copies of the syllabi or word documents were received they were converted into a searchable form of PDF. After all the syllabi were converted to PDF's they were saved to one folder. A list was compiled of all the syllabi that had been received. Within that list the syllabi that were received were sorted by entry- or advanced-level courses. The entry level courses were simply the first class in the series of courses taught at that college or university or were classified as such because they were the only course taught. The advanced level courses were any course that was not classified as an entry level course.

Using the find tool within Adobe Acrobat all the syllabi were searched for each topic phrase. There were variations made of all of the topic phrases to correctly search each syllabus. The topics were searched based on acronyms (e.g., "GPS" for "Global Positioning System") or the order in which certain words would appear (e.g., "yield monitor" or "monitor yield") or abbreviations (e.g., "vari" for "variability" or "variable" or "manage" for "management" or "managements"). A total of 59 topic categories were searched within each syllabi (*Appendix B*). Once all topics were searched, a tally was created to see the number of times a topic phrase was listed. The topics were ordered in relation to the frequency that they were found in syllabi. Once the topics were tallied they were separated based on whether they were an entry level course or an advanced level course.

Results

A total of 24 schools sent in 43 syllabi to be evaluated (*Fig 1*). While most of the syllabi came from the central part of the United States, there were syllabi received from California, Washington, Idaho, and Montreal, Canada. The syllabi were searched to find any prerequisites that were required or recommended for each course. Nineteen of the syllabi had no prerequisites listed. Eight courses required the students to have had college algebra or an equivalent. Four of the syllabi required an introductory PA class before they could enroll in a second (advanced level) PA course (*Table 1*). Within the 43 course syllabi there were only two syllabi that listed a suggested prerequisite for their course. The two suggested prerequisites were: 1) an understanding of crop production and agronomic principles and 2) previous precision agriculture courses.

Fig 1. Colleges/Universities that provided syllabi, shown by location.

Table 1. Prerequisites required for students enrolled in PA courses (N=43)

Prerequisite Listed	# of Syllabi	Prerequisite Listed	# of Syllabi
None	19	GIS	2
College Algebra	8	Farm Management	2
Precision Ag (Intro.)	4	Agribusiness	1
Junior/Senior Standing	4	Insect Biology	1
Physics	3	Remote Sensing	1
Soils	3	Statistics	1
Graduate Standing	3	Basic Computing Class	1
Plant Pathology	2		

A total of 15 syllabi required *The Precision-Farming Guide for Agriculturists* (Ess and Morgan 2010) as text for the course (34.9%, N=43). Another three syllabi had the text listed as optional text for the course. Nine of the syllabi had the required text listed as: None (21%, N=43). Six of the syllabi had listed course notes for their required reading (14%, N=43). The most commonly used textbook (Ess and Morgan 2010) for these precision agriculture courses was last updated in 2010. There have been five years of advancements that have not been included in the latest edition of this text for PA classes.

The data was collected and put in a table to examine the frequency that each topic phrase surfaced. The researchers analyzed the frequency in which topics appeared for any entry level course. Variable Rate Technology and GIS are the most commonly taught topics within these entry level courses with 21 and 23 instances, respectively. (*Fig 2.*)

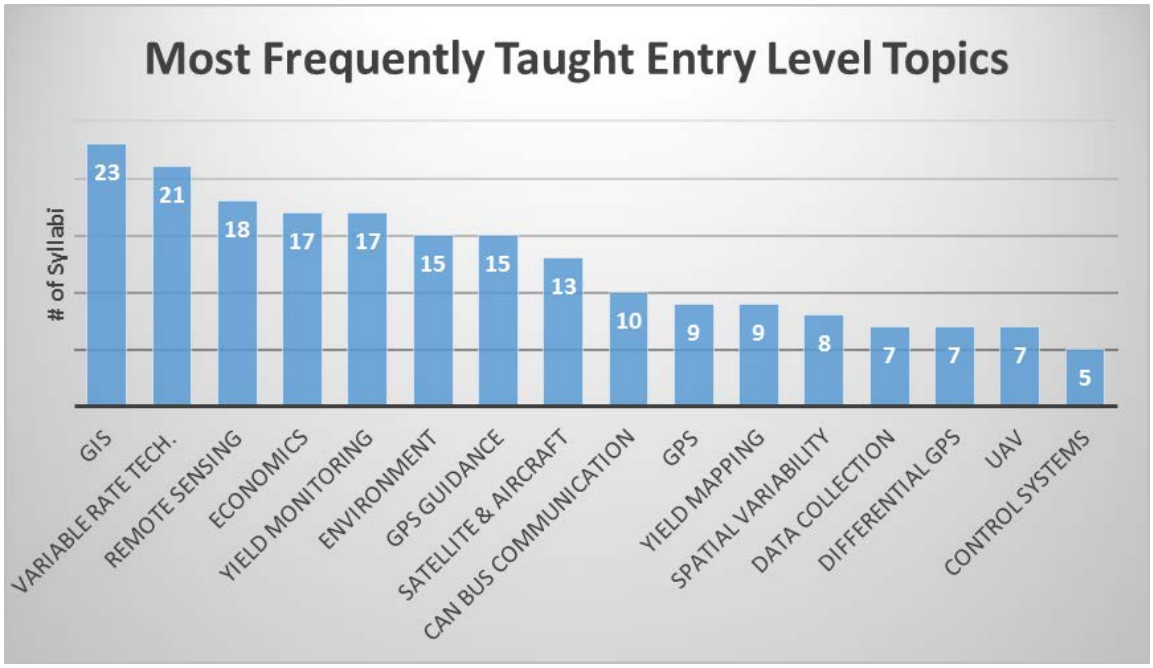

Fig. 2 Most frequently taught entry level topics (N=43)

The researchers analyzed the topic phrases that were only found in entry level courses. These findings are reported in *Fig 3*. Few topic phrases were taught only within an entry level course. The most frequent of those topic phrases only taught in entry level courses were coordinate systems, map projections, and GPS accuracy.

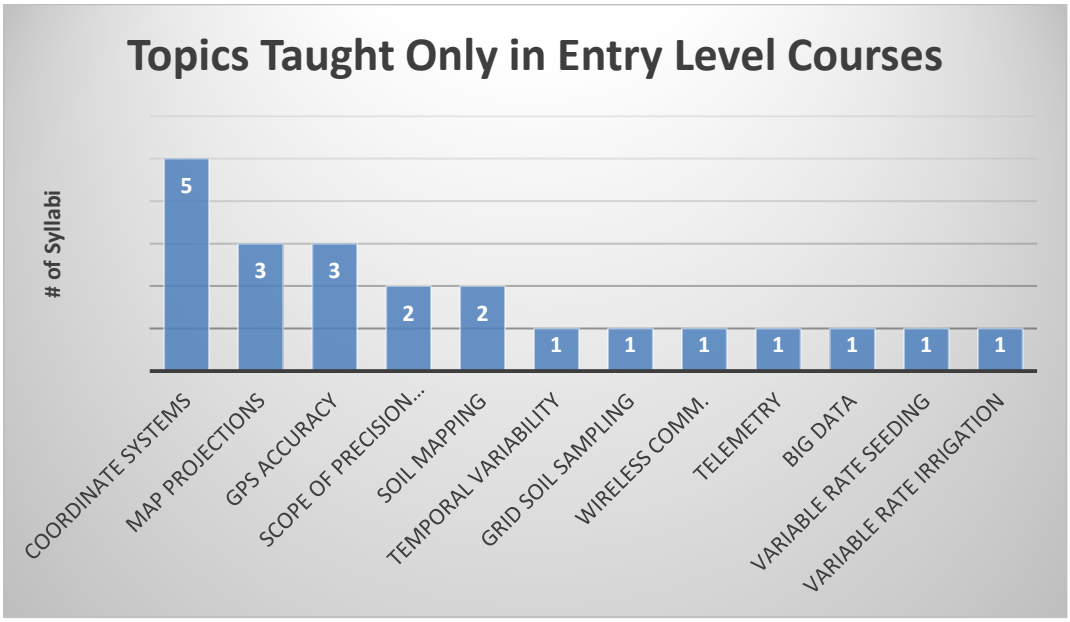

Fig 3. Topics taught only in entry level courses (N=43)

The researchers next wanted to see how many of the topic phrases that were listed were taught within both an entry level and an advanced level course (*Fig 4*). The overall findings of the researchers was that the topic phrases were introduced within an entry level course and then also reintroduced or expounded upon in an advanced level course.

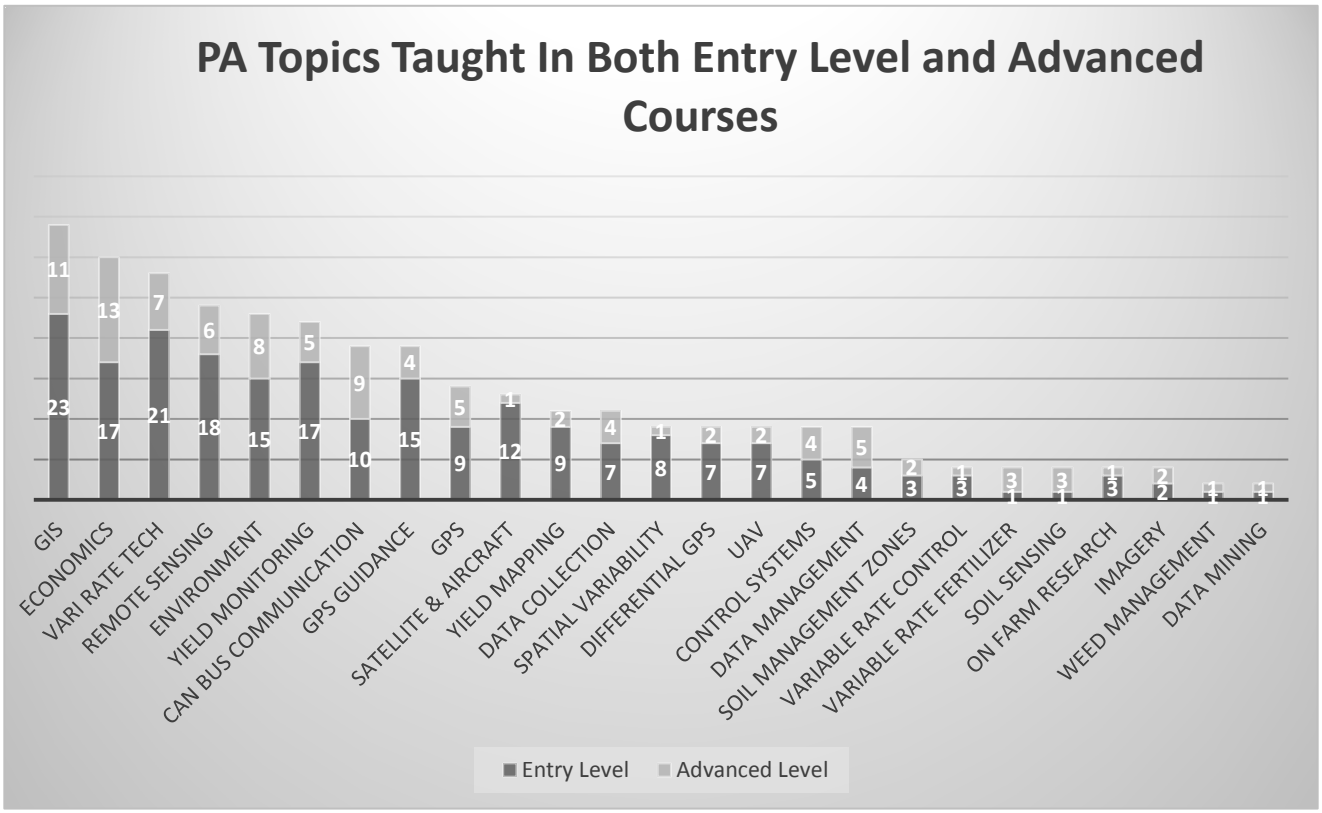

Fig 4. Topics taught in both entry and advanced courses (N=43)

The researchers then concluded their analysis by seeing what, if any, topic phrases were only taught in advanced level courses. There were three topics that were only found taught in the advanced courses; pest management (which was found in two syllabi), disease management, and data

interpretation. The last two topic phrases only appeared once in advanced level courses.

There were several topic phrases that, when searched, yielded no responses for entry level or advanced level courses. *Table 2* shows the list of topic phrases not found in syllabi. The researchers were surprised that not even one professor taught some of these topic phrases. The researchers concluded that the teachers most likely did cover these topics within the classroom but did not include every topic phrase that was discussed during class in the syllabi.

Table 2. Topics with zero occurrences (N=43)

Weather Variability	Product Comparisons	Crop Sensing
Yield Monitor Calibration	Data Compatibility	Nitrous Oxide
Yield Map Cleaning	Data Ownership	Ultrasonic
Yield Stability	Eutrophication	Machine Vision
Soil Variability	Leaching	Variable Rate Pest
Topography	Hypoxia	
Insect Management	Soil Erosion	

Discussion

The compiled results were presented to the entire research team involved in the USDA challenge grant. The consensus was that many of the syllabi lacked enough specific detail to accurately determine which topic phrases were taught or not taught among institutions. There were instances where a teacher would state that they indeed did teach certain topics, but those topic phrases were marked as having no findings. The research team reasoned that it would also be beneficial to know the amount of time that professors spend on each topic that they teach in the classroom.

Conclusion

The research team concluded that though there were several findings that helped to acknowledge the most common topic phrases taught in PA, there was insufficient detail about topics found when searching the courses' syllabi. The syllabi in general were too broad to accurately draw any conclusions and did not give a good representation of the topics that instructors across the nation teach in PA. The researchers also felt that they did not get a larger number of syllabi because of liability and intellectual property issues with letting researchers see the teacher's syllabi. The team subsequently agreed that more research was needed to acquire information about the topic phrases that were/are covered in PA courses. A new survey has been developed and is going through the process of Institutional Review Board (IRB) approval. The survey will be sent to the same teachers that provided copies of their course syllabi and any future instructors that the group has found by word of mouth or google searches.

Acknowledgements

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Appendix

Appendix A: Initial Letter

UNIVERSITY *of* MISSOURI

AGRICULTURAL SYSTEMS MANAGEMENT

August 5, 2015

Greetings,

We are working with Universities across the nation to update the material used to teacher Precision Agriculture. As we have looked into your course offerings we found you teach a Precision Agriculture course. We are hoping that you would be willing to share a copy of your course syllabus from your Precision Agriculture course.

We are hoping to ultimately establish some common language between Precision Agriculture instructors/operators within the industry as well as looking at the sequencing of the information within the courses taught. Is it possible for you to send a copy of your syllabus by Tuesday, August 18, 2015? We would greatly appreciate any help you could provide.

If you have further questions, please feel free to call 573-882-2731.

Sincerely,

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Appendix B: List of topic phrases/keywords searched in each syllabus

Topic Name	Phrases Searched
GIS	Geographic Information Systems/ GIS
Economics	Economic/ Profit/ Benefit/ Economic Benefit
Variable Rate Technology	VRA/ Variable Rate/ Variable Application
Remote Sensing	Remote Sens
Environment	Environment
Yield Monitoring	Yield Monitor/ Monitor Yield
CAN BUS Communication	ISOBUS/ CAN/ Communication
GPS Guidance	Guidance/ Auto Guide/ Auto Steer
GPS	GPS
Aircraft & Satellite	Satellite/ Aircraft/ Aerial
Yield Mapping	Yield Map/ Map Yield
Data Collection	Data Collect
Spatial Variability	Spatial Vari
Differential GPS	DGPS/ RTK/ CORS
UAV	UAV/ Unmanned Aircraft/ Drone
Control Systems	Control Systems/ Equip Control/ Section Control/ Nozzle Control/ Boom Control
Data Management	Data Manage
Coordinate Systems	Coordinate Systems
Soil Management Zones	Soil Manage/ Soil Zone/ Management Zone
Soil Sensing	Soil Sensing/ Electrical Conductivity/ EC/ pH Sensing/ NIRS
On Farm Research	On-Farm Trial / On farm trial / On farm test / On-farm test / On farm research / On-farm research
Variable Control	Variable Control/ variable rate control
Variable Rate Nutrient	Variable Fertilize/ Variable Nitrogen/ Variable N/ variable rate nutrient
Imagery	Imagery
Map Projection	Map Projection
GPS Accuracy	GPS Accuracy
Scope of Precision Agriculture	Scope of Precision
Soil Mapping	Soil Map
Weed Management	Weed Measure/ Weed Manage/ Weed Assess/ Weed Control
Pest Management	Pes Measure/ Pest Manage/ Pest Assess/ Pest Control
Data Mining	Data Mining
Temporal Variability	Temporal Vari
Grid Soil Sampling	Soil Sample/ Grid Sample/ Grid Soil Sample
Disease Management	Disease Measure/ Disease Manage/ Disease Assess/ Disease Control
Wireless Communication	Wireless
Telemetry	Telemetry
Data Interpretation	Data Interpret
Big Data	Big Data
Variable Rate Seeding	Variable Seed/ variable rate seeding
Variable Rate Irrigation	Variable Water/ Variable Irrigation/ variable rate irrigation
Weather Variability	Weather Vari
Yield Monitor Calibration	Yield Monitor/ Monitor Yield/ yield monitor calibration

Yield Map Cleaning	Yield Clean/ Clean Yield/ yield map cleaning
Yield Stability	Yield Stability
Soil Variability	Soil Vari
Topography	Topo
Insect Management	Insect measure/ Insect Manage/ Insect Assess/ Insect control
Crop Sens	Proximal Sensing/ Optical Sensing/ Active Sensing/ Canopy Sensing
Ultrasonic	Ultrasonic
Machine Vision	Machine Vision
Product Comparisons	Product Comparisons
Data Compatibility	Data Compatibility
Data Ownership	Data Owner
Eutrophication	Eutrophication
Leaching	Leaching
Hypoxia	Hypoxia
Soil Erosion	Soil Erosion
Nitrous Oxide	Nitrous oxide
Variable Rate Pest	Variable Rate Pest