

CROP AND SOIL SCIENCES

CSS

Department of Crop and Soil Sciences College of Agriculture and Natural Resources

101 Introduction to Crop Science Fall. 3(2-2)

Principles of crop production including crop and soil management and improvement. International and sustainable agriculture. Water quality issues.

110 Computer Applications in Agronomy Fall. 2(1-2) R: Open only to students in the College of Agriculture and Natural Resources. Not open to students with credit in CSE 101.

Use of computers in agriculture. Basic computer operating systems. Management and use of storage media. Laboratory experience in word processing, spread sheets, data bases, programming languages, networking, and software related to agriculture.

135 Crop Scouting and Investigation Spring. 2(3-0) P:M: CSS 101

Crop production, pest scouting and other production problems, and field diagnoses. Interaction with agriculture clientele.

151 Seed and Grain Quality Spring. 2(2-2) SA: CSS 051

Principles and practices of producing, conditioning, testing and marketing field crop seed. Grain grading and quality evaluation.

156 Weed Management Fall. 3(2-2) R: Open only to freshmen or sophomores. Not open to students in Crop and Soil Sciences.

Cultural, mechanical, biological, and chemical weed management practices in agronomic crops.

171 Operations Budgeting for Golf Course Managers Spring. 2(3-0) RB: CSS 232 and CSS 210 Not open to students with credit in CSS 071.

Budgeting. Financial analysis. Purchasing and materials management for golf course operations.

178 Golf Turf Irrigation Spring. 2(2-2) Not open to students with credit in CSS 078.

Golf course irrigation systems: installation and maintenance including water management.

181 Pesticide and Fertilizer Application Technology Spring. 3(3-3) SA: CSS 081

Effective and efficient application of pesticides and fertilizers to turf and ornamentals. Pesticide handling, legal, and environmental concerns. Calibration of equipment.

192 Professional Development Seminar I Spring. 1(0-2) R: Open only to students in the Department of Crop and Soil Sciences.

Career development, critical issues analysis, resume writing, scientific presentations and public speaking in crop and soil sciences.

201 Forage Crops Fall. 3(2-2)

Forage crop production, management, and utilization. Crop identification. Soil fertilization. Planting and harvesting of grasses and legumes.

210 Fundamentals of Soil Science Fall, Spring. 3(2-3) RB: CEM 141

Agricultural and natural resource ecosystems: soil, vegetation, and ground water components. Energy, water, and nutrient cycles. Soil classification and mapping. Land management and use issues.

211 Turfgrass and the Environment Spring. 2(3-0) P:M: CSS 232 RB: CSS 210

Pesticide and nutrient fate, site assessment, fuel use, equipment washing systems and criteria for recognizing sensitive sites. Conservation and best management practices to maximize protection of natural resources.

212 Advanced Crop Production Fall. 2(2-0) P:M: CSS 101 RB: CSS 210 and CSS 110

Systems approach to production of field crops including corn, soybeans, small grains, sugar beets, and dry beans.

222 New Horizons in Biotechnology Fall. 2(2-0) Interdepartmental with Entomology. Administered by Crop and Soil Sciences.

Perspectives on biotechnology for safer food production, environmental quality, and improved human health. Impacts of biotechnology on the national economy. Political and ethical ramifications of applied biotechnology.

232 Introduction to Turfgrass Management Fall. 3(2-2) P:M: CSS 210 or concurrently RB: CSS 110 or CSE 101

Turfgrass utilization, identification, establishment and management principles. Responses to various cultural practices.

242 Athletic Field Maintenance and Construction Fall. 2(2-0) P:M: (CSS 232 or concurrently) and (CSS 210 or concurrently)

Maintenance, renovation, and construction of athletic fields with emphasis on baseball and football. Soil testing, cultivar selection, and surveying. Safety and liability concerns.

262 Turfgrass Management Seminar Fall. 1(2-0) A student may earn a maximum of 2 credits in all enrollments for this course. P:M: CSS 232 or concurrently

Presentations by turf students and industry professionals. Topics include internship experiences, technical expertise, and keys to successful career pathways.

264 Golf Course Design and Construction Techniques Fall. 2(2-0) P:M: CSS 210 and CSS 232 and CSS 267 SA: CSS 164

Concepts and theory of golf course design and construction including location, space, topography, clientele, and environmental concerns.

267 Turfgrass Practices Spring. 2(2-2) P:M: CSS 232 SA: CSS 067

Turfgrass establishment, renovation, and construction principles. Maintenance of golf course turf. Agronomic and management principles applied to golf course maintenance.

269 Turfgrass Strategies Spring. 2(3-0) P:M: CSS 232

Issues in turfgrass management including employee relations, construction, and environmental problems.

272 Turfgrass Soil Management Fall. 3(2-2) RB: CSS 043 or CSS 210 Not open to students with credit in CSS 044 or CSS 342.

Impact of fertilization programs on turfgrasses and the environment. Irrigation, drainage, cultivation, top dressing, amendments and pH control of turfgrass soils.

290 Independent Study in Crop and Soil Science Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to students in the Institute of Agricultural Technology. SA: CSS 057 Not open to students with credit in CSS 057.

Field, laboratory, or library research problems.

292 Management of Turfgrass Weeds Spring. 2(2-2) P:M: CSS 232 RB: BOT 105

Chemical, biological, and cultural methods of managing turfgrass weeds. Environmental considerations in weed management.

310 Soil Management and Environmental Impact Spring. 3(3-0) P:M: CSS 210

Management of soil physical and chemical properties for the production of food and fiber. Soil management systems that reduce the environmental impact on soil, water and air resources and maximize crop production potential.

330 Soil Chemistry Spring. 2(2-2) P:M: CSS 210 and CEM 143

Organic and inorganic soil processes including mineralogy, adsorption, desorption, and precipitation. Chemistry of soil organic matter and inorganic soil components.

340 Applied Soil Physics Spring. 2(2-2) P:M: CSS 210

Soil physical properties including solids, water, air, and heat. Transport processes in soil.

350 Introduction to Plant Genetics Spring. 3(4-0) P:M: BOT 105 or BS 111 R:

Not open to freshmen or sophomores. Fundamentals of plant genetics with applications to agriculture and natural resources.

355 Environmental Soil Chemistry Fall. 3(2-2) P:M: (CEM 143 and CSS 210)

Soil chemistry concepts as they apply to major chemical groups of environmental importance including metals, nitrogen, phosphorus, organic contaminants, and pesticides.

360 Soil Biology Fall. 3(2-2) P:M: CSS 210 RB: CSS 330

Overview of organismal diversity and biological soil processes. Role of macroorganisms and microorganisms in soil processing, including nutrient cycling.

362 Management of Turfgrass Pests Fall. 4(3-2) Interdepartmental with Entomology and Plant Pathology. Administered by Crop and Soil Sciences. P:M: CSS 232

Chemical, biological, and cultural methods of managing weeds, diseases, and insect pests of turfgrass. Environmental considerations in pest management.

Crop and Soil Sciences—CSS

- 380 Crop Physiology**
Spring of even years. 3(2-3) P:M: CSS 101 and (BOT 105 or BOT 301)
Physiological and metabolic function of plants from a whole plant viewpoint. Environmental effects on crop growth, development, and yield.
- 382 Turfgrass Physiology**
Spring. 2(3-0) Interdepartmental with Horticulture. Administered by Crop and Soil Sciences. P:M: (CSS 232) Completion of Tier I writing requirement. RB: PLB 105 SA: CSS 282, CSS 068 Not open to students with credit in CSS 332.
Physiological principles of turfgrass growth and development. Water relations, light, temperature, respiration, photosynthesis, mineral nutrition, and hormone action. Impact of mowing, cultivation, and traffic on turfgrass growth.
- 402 Principles of Weed Science**
Fall. 3(2-2) RB: BOT 105 and CEM 143 R: Not open to freshmen or sophomores.
Weed biology and ecology. Cultural, mechanical, biological, and chemical control practices. Herbicide action, selectivity in plants, and effects on environment.
- 404 Forest and Agricultural Ecology**
Fall. 3(3-0) Interdepartmental with Forestry. Administered by Forestry. P:M: CSS 210 and (BOT 105 or BS 110) RB: ZOL 355
Ecological interactions crucial to the sustainable management of crop and forest ecosystems. Plant resources, competition, community development and dynamics, biodiversity, primary productivity, nutrient cycling, ecosystem structure and function, and impacts of global environmental change.
- 404L Forest and Agricultural Ecology Laboratory**
Fall. 1(0-3) Interdepartmental with Forestry. Administered by Forestry. P:M: CSS 210 and (BOT 105 or BS 110) and (FOR 404 or concurrently) RB: ZOL 355
Field studies and data analysis of ecological processes central to the sustainable management of forest and agricultural resources. Field exercises cover primary production, community structure, soil resources, biodiversity, succession, nutrient cycling, critiques of primary literature. Two weekend field trips required.
- 406 Seed Production and Technology**
Fall of even years. 3(2-2) P:M: CSS 101 and CSS 350 R: Not open to freshmen or sophomores.
Principles and practices of field seed production. Crop improvement, variety release, seed production, seed technology and evaluation involved in producing high quality field crop seed.
- 425 Microbial Ecology**
Spring. 3(3-0) Interdepartmental with Microbiology and Molecular Genetics. Administered by Microbiology and Molecular Genetics. RB: MMG 301 SA: MPH 425
Microbial population and community interactions. Microbial activities in natural systems, including associations with plants or animals.
- 426 Biogeochemistry**
Summer. 3 credits. Interdepartmental with Geological Sciences and Microbiology and Molecular Genetics and Zoology. Administered by Microbiology and Molecular Genetics. RB: (BS 110 or LBS 144 or LBS 148H or BS 111 or LBS 145 or LBS 149H) and (CEM 143 or CEM 251) SA: MPH 426
Integration of the principles of ecology, microbiology, geochemistry, and environmental chemistry. Societal applications of research in aquatic and terrestrial habitats.
- 430 Soil Fertility and Chemistry**
Spring. 3(2-2) P:M: CSS 210 R: Not open to freshmen or sophomores.
Application of chemistry to diagnosing and improving soil fertility. Soil amendments including macro- and micro-nutrients. Reducing environmental degradation.
- 431 Soil and Plant Resources for Sustained World Food and Fiber Production**
Spring of odd years. 3(3-0) P:M: CSS 101 and CSS 210
World food and fiber production capacities related to soil and climatic resources. Management and utilization of genetic resources for sustained production of human foods and animal feeds.
- 440 Soil Biophysics**
Fall of even years. 3(2-2) P:M: CSS 210 R: Not open to freshmen or sophomores.
Plant growth properties and soil physical conditions which influence productivity. Principles and applications of soil texture, structure, mechanical impedance, aeration and water. Root responses to the environment.
- 441 Plant Breeding and Biotechnology**
Spring of even years. 3(3-0) Interdepartmental with Forestry and Horticulture. Administered by Crop and Soil Sciences. P:M: CSS 101
Plant improvement by genetic manipulation. Genetic variability in plants. Traditional and biotechnological means of creating and disseminating recombinant genotypes and cultivars. Importance of plant breeding to our food system, economy, and environment.
- 451 Biotechnology Applications for Plant Breeding and Genetics**
Spring. 3(2-2) Interdepartmental with Forestry and Horticulture. Administered by Crop and Soil Sciences. RB: (CSS 350 or ZOL 341) and CSS 441
Principles, concepts, and techniques of agricultural plant biotechnology. Recombinant DNA technology, plant molecular biology and transformation in relation to plant improvement.
- 455 Pollutants in the Soil Environment**
Fall. 3(3-0) P:M: (CEM 143) and completion of Tier I writing requirement. R: Open only to seniors or graduate students.
Chemical and biological reactions of organic and inorganic pollutants in soils.
- 464 Statistics for Biologists**
Fall. 3(3-0) Interdepartmental with Animal Science and Statistics and Probability. Administered by Statistics and Probability. RB: STT 421
Biological random variables. Estimation of population parameters. Testing hypotheses. Linear correlation and regression. Analyses of counted and measured data to compare several biological groups including contingency tables and analysis of variance.
- 470 Soil Resources**
Fall. 3(2-3) RB: CSS 210 R: Not open to freshmen or sophomores.
Evaluation of the properties, genesis, and classification of soil resources to assist in making land-use decisions.
- 477 Pest Management I: Pesticides in Management Systems**
Fall. 3(3-0) Interdepartmental with Entomology and Fisheries and Wildlife and Horticulture. Administered by Entomology. RB: (CEM 143 or CEM 251) and (BOT 405 and CSS 402) and (ENT 404 or ENT 470 or FW 328)
Chemistry, efficient use, and environmental fate of pesticides. Legal and social aspects of pesticide use.
- 478 Pest Management II: Biological Components of Management Systems (W)**
Spring of even years. 3(2-3) Interdepartmental with Entomology and Forestry and Fisheries and Wildlife and Horticulture. Administered by Entomology. P:M: (ENT 404 or ENT 470 or PLP 405 or CSS 402) and completion of Tier I writing requirement
Principles of host plant resistance and biological control and their relationship to the design of agroecosystems. Classification of insect biological control agents.
- 480 Soil Fertility and Management**
Fall. 3(3-0) P:M: CSS 101 and CSS 330 and CSS 340 and CSS 360 and (CSS 470 or concurrently)
Comprehensive management of agricultural soils. Soil fertility, including liming and fertilizer materials and other nutrient sources. Site specific soil management. Environmental impacts including soil erosion, runoff, and organic matter mineralization.
- 486 Biotechnology in Agriculture: Applications and Ethical Issues**
Fall of even years. 3(3-0) Interdepartmental with Forestry and Horticulture and Philosophy. Administered by Horticulture. P:M: BOT 105 or BS 111 RB: CSS 350 or ZOL 341 R: Not open to freshmen or sophomores.
Current and future roles of biotechnology in agriculture: scientific basis, applications. Environmental, social, and ethical concerns.
- 488 Agricultural Cropping Systems: Integration and Problem Solving**
Spring. 3(2-2) P:M: (CSS 101 and CSS 210) and completion of Tier I writing requirement. RB: (CSS 310 and CSS 430 and PLP 405 and ENT 404) and Course work in crop production and management. R: Open only to seniors in the College of Agriculture and Natural Resources.
Integration and synthesis of agronomic and related concepts in agricultural cropping systems. Problem solving and application of information.
- 490 Independent Study**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P:M: CSS 101 or CSS 210 R: Approval of department; application required.
Individual work on field, laboratory, or library research problem of special interest to the student.

491 Special Topics

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P:M: CSS 101 or CSS 210

Topics from crop production, crop physiology, turfgrass management, organic soils, turfgrass soils, soil fertility, plant and soil relationships, genetics, biotechnology, environmental science, or sustainable agriculture.

492 Professional Development Seminar II

Fall. 1(0-2) P:M: (CSS 192 or CSS 262) and (CSS 210 and completion of Tier I Writing requirement) R: Open only to seniors in the Department of Crop and Soil Sciences.

Synthesis, integration and application of agronomic principles to current issues in agronomy via discussion and oral and written communication.

493 Professional Internship in Crop and Soil Sciences

Fall, Spring, Summer. 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P:M: Completion of Tier I writing requirement. R: Approval of department; application required. A student may earn a maximum of 6 credits for any or all of these courses: ABM 493, AEE 493, ANR 493, ANS 493, CSS 493, EEP 493, FIM493, FW 493, HRT 493, PKG 493, PLP 493, PRR 493, and RD 493.

Supervised professional experiences in agencies and businesses related to crop and soil sciences and environmental soil sciences.

494 International Agriculture Seminar

Spring of odd years. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. P:M: Completion of Tier I writing requirement.

Global food, soil and water resources issues.

499 Undergraduate Research

Fall, Spring, Summer. 3(0-9) R: Approval of department; application required.

Faculty supervised research in a selected area of crop and soil sciences or environmental soil science.

802 Weed Biology

Spring of even years. 2(2-0) RB: A previous course in weed science or plant biology or ecology.

Weed biology, including weed seed production and dispersal and seed fate. Weed life history traits and ecophysiology, including invasive species. Data collection in weed ecology research.

805 Herbicide Action and Metabolism

Spring of odd years. 2(2-0)

Properties and characteristics of herbicides. Processes involved in herbicide action, transport, and fate in plants and soils.

814 Advanced Statistics for Biologists

Spring. 4(3-2) Interdepartmental with Animal Science and Statistics and Probability. Administered by Statistics and Probability. RB: STT 464

Concepts of reducing experimental error for biological and agricultural research. Covariance, randomized block designs, latin squares, split plots, repeated-measures designs, regression applications, and response surface designs. Analyses using statistical software.

819 Advanced Plant Breeding

Fall. 3(3-0) Interdepartmental with Forestry and Horticulture. Administered by Horticulture. RB: CSS 450 and STT 422

Genetic expectations resulting from breeding strategies with cross- and self-pollinated crop plants. Germplasm collections, mapping populations, and modifications of reproductive biology useful for crop improvement.

820 Plant Reproductive Biology and Polyploidy

Spring of odd years. 1(3-0) Interdepartmental with Forestry and Horticulture and Plant Biology and Plant Pathology. Administered by Horticulture. RB: Introductory Genetics and Plant Biology

Genetic processes underlying variations in plant reproductive biology and polyploidy. Utilization of these characteristics in plant breeding.

821 Crop Evolution

Spring of odd years. 1 credit. Interdepartmental with Forestry and Horticulture and Plant Biology and Plant Pathology. Administered by Horticulture. RB: Introductory Genetics and Plant Biology

Cultural and biological aspects of the evolution of domestic plants.

822 Historical Geography of Crop Plants

Spring of odd years. 1 credit. Interdepartmental with Forestry and Horticulture and Plant Biology and Plant Pathology. Administered by Horticulture. RB: Introductory Genetics and Plant Biology

Development and spread of the major crop species.

825 Clay Mineralogy and Soils Genesis

Spring of even years. 4(3-2) Interdepartmental with Geological Sciences. Administered by Crop and Soil Sciences. R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science.

Mineral structures. X-ray diffraction, pedogenic processes, and mineral transformations and stability.

827 Techniques in Cytogenetics

Fall of odd years. 1(0-3) Interdepartmental with Forestry and Horticulture. Administered by Crop and Soil Sciences.

Preparation of chromosomes from commercially important plants for cytogenetic analysis.

837 Confocal Microscopy

Fall, Spring. 2(2-2) Interdepartmental with Natural Science. Administered by Natural Science.

Confocal imaging, theory and practice. Basic optics. Lasers. Light paths for transmission, fluorescence and reflection. Image quality, analysis and processing.

840 Soil Physics

Fall of odd years. 3(2-3) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science.

Physical properties of soil including texture, structure, consistency, aeration, moisture content, and temperature. Quantitative measurement of plant growth. Agronomic and engineering practices.

841 Soil Microbiology

Spring of even years. 3(3-0) Interdepartmental with Microbiology and Molecular Genetics. Administered by Microbiology and Molecular Genetics. RB: MMG 425 SA: MPH 841

Ecology, physiology, and biochemistry of microorganisms indigenous to soil.

842 Population Genetics, Genealogy and Genomics

Fall. 3(3-0) Interdepartmental with Animal Science and Forestry and Fisheries and Wildlife and Genetics and Horticulture. Administered by Forestry. RB: Pre-calculus, basic genetics

Population genetic processes underlying patterns of molecular genetic variation. Genealogical approaches to the study of genomic diversity, phylogenetic reconstruction, and molecular ecology.

850 Soil Chemistry

Spring. 3(3-3) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science.

Ion activities, ionic exchange and equilibrium reactions. Soil pH, macro- and micronutrients, saline soils and availability of nutrients to plants.

853 Plant Mineral Nutrition

Fall of odd years. 3(3-0) Interdepartmental with Horticulture. Administered by Crop and Soil Sciences. RB: BOT 301

Inorganic ion transport in plant cells and tissues. Physiological responses and adaptation to problem soils. Genetic diversity in nutrient uptake and use by plants. Physiological roles of elemental nutrients in crop growth.

856 Plant Molecular Biology

Spring. 3(3-0) Interdepartmental with Biochemistry and Molecular Biology and Plant Biology. Administered by Plant Biology. RB: ZOL 341 SA: BOT 856

Recent advances in genetics and molecular biology of higher plants.

863 Mineral-Water Interactions

Fall of even years. 4(3-2) Interdepartmental with Geological Sciences. Administered by Geological Sciences. R: Open only to graduate students in the Department of Crop and Soil Sciences or Department of Geological Sciences or Department of Geography.

Mineralogy, petrology and geochemistry of fluid-rock reactions in geologic, sedimentary and geochemical cycles. Rock and mineral weathering, soil formation, genesis and burial diagenesis of sediments and sedimentary rocks, and metamorphism.

865 Organic Chemistry of Soils

Spring of odd years. 2(2-0)

Chemistry of natural and anthropogenic organic substances in soils.

Crop and Soil Sciences—CSS

870 Techniques of Analyzing Unbalanced Research Data

Spring. 4(4-0) Interdepartmental with Animal Science and Forestry and Fisheries and Wildlife and Horticulture. Administered by Animal Science. RB: STT 464 R: Open only to graduate students in the College of Agriculture and Natural Resources. SA: ANS 943

Linear model techniques to analyze biological research data characterized by missing and unequal number of observations in classes. Simultaneous consideration of multiple factors. Prediction of breeding values and estimation of population parameters from variance and covariance components.

880 Scientific Communication and Professional Development

Spring. 1(0-2)

Interactive professional experiences including grant preproposal preparation and presentation, scientific presentations, mock position interviews, and resume preparation.

890 Independent Study

Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science.

Individual study on field, laboratory, or library research.

891 Current Topics in Ecology and Evolution

Summer. 1 to 2 credits. A student may earn a maximum of 10 credits in all enrollments for this course. Interdepartmental with Plant Biology and Zoology. Administered by Zoology.

Presentation and critical evaluation of theoretical and empirical developments in ecology and evolutionary biology by visiting scientists.

891B Selected Topics in Plant Breeding and Genetics

Fall, Spring, Summer. 1 to 2 credits. A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Forestry and Horticulture. Administered by Horticulture. R: Open only to graduate students in the Plant Breeding and Genetics major or Genetics major. Approval of department.

Selected topics in plant breeding.

892 Plant Breeding and Genetics Seminar

Fall, Spring, Summer. 1(1-0) A student may earn a maximum of 8 credits in all enrollments for this course. Interdepartmental with Forestry and Horticulture. Administered by Horticulture.

Experience in review, organization, oral presentation, and analysis of research.

893 Selected Topics

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science.

Selected topics in crop and soil sciences of current interest and importance.

899 Master's Thesis Research

Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to master's students in the Department of Crop and Soil Sciences.

Master's thesis research.

921 Contemporary Statistical Models in Biology

Fall of odd years. 3(3-0) RB: (STT 465) or approval of department. Working knowledge of SAS software.

Estimating functions. Growth models, generalized linear models, linear and non-linear mixed models. Field experiments with spatial trends. Longitudinal data. Modeling in the presence of spatial and temporal correlations.

941 Quantitative Genetics in Plant Breeding

Spring of even years. 3(2-2) Interdepartmental with Forestry and Horticulture. Administered by Crop and Soil Sciences. RB: CSS 819 and STT 464

Theoretical and genetic basis of statistical analysis of quantitative traits using genetic markers. Computational tools for the study of quantitative traits.

999 Doctoral Dissertation Research

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to doctoral students in the Department of Crop and Soil Sciences.

Doctoral dissertation research.