

AGRONOMY

Undergraduate Study

Agronomy is the science and technology of producing plants that serve humans, using practices essential for maintaining and improving life. The Department of Agronomy offers a major leading to a degree of bachelor of science (BS) in agronomy. Graduates have the theoretical and practical knowledge needed for efficient and sustainable crop production. They are skilled in critical thinking, problem solving, and communicating and working effectively with others. They understand the ethical, cultural, and environmental dimensions of issues facing agronomists globally.

An agronomy major prepares students for employment in crop production and soil management, yield forecasting, precision farming, plant breeding, agricultural business and industry, agricultural service organizations, environmental and natural resource management, and farm management. Graduates pursue careers in the seed, fertilizer, and agricultural chemical industries as field agronomists, crop and soil management specialists, research technicians, sales and marketing specialists, and production managers. State and federal agencies employ agronomists as extension specialists, county extension directors, environmental and natural resource specialists, research associates, soil surveyors, soil conservationists, grain inspectors, integrated pest management, land appraisal, agricultural finance, and in other science-based professional positions.

An agronomy major also prepares students for graduate school. We offer a concurrent BS/MBA degree. About a quarter of our students immediately continue into research-based MS and PhD programs. As an undergraduate, there are many opportunities to be involved in research

Department of Agronomy website - <http://www.agron.iastate.edu/>.

Curriculum in Agronomy

Total Degree Requirement: 128 cr.

Only 65 cr. from a two-year institution may apply which may include up to 16 technical cr.; 9 P-NP cr. of free electives; 2.00 minimum GPA. A minimum of 15 credits of agronomy courses must be earned at Iowa State and not transferred from other institutions.

International Perspective: 3 cr.

3 cr. from approved International Perspective list: <http://www.registrar.iastate.edu/students/div-ip-guide/IntlPerspectives-current>

U.S. Diversity: 3 cr.

3 cr. from approved U.S. Diversity list: <http://www.registrar.iastate.edu/students/div-ip-guide/usdiversity-courses>

Communication/Library: 13 cr.

6 cr. of English composition with a C or better and 3 cr. of speech fundamentals with a C or better.

ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
SP CM 212	Fundamentals of Public Speaking	3
or AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	
LIB 160	Information Literacy	1
One of the following:		
ENGL 302	Business Communication	3
ENGL 309	Proposal and Report Writing	3
ENGL 314	Technical Communication	3

Humanities: 3 cr.

3 cr. from approved humanities list: <http://www.cals.iastate.edu/student-services/humanities>

Social Sciences: 3 cr.

3 cr. from approved social sciences list: <http://www.cals.iastate.edu/student-services/social-sciences>

Ethics: 3 cr.

3 cr. from approved ethics list: <http://www.cals.iastate.edu/student-services/ethics>

Mathematical Sciences: 6 cr.

MATH 140	College Algebra	3
STAT 104	Introduction to Statistics	3

Physical Sciences: 8 cr.

CHEM 163 & 163L	College Chemistry and Laboratory in College Chemistry	5
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One of the following:

AGRON 259	Organic Compounds in Plants and Soils	3
BBMB 221	Structure and Reactions in Biochemical Processes	3
CHEM 231 & 231L	Elementary Organic Chemistry and Laboratory in Elementary Organic Chemistry	4

Life and Biological Sciences: 7 cr.

BIOL 212 & 212L	Principles of Biology II and Principles of Biology Laboratory II	4
AGRON 320 or BIOL 313	Genetics, Agriculture and Biotechnology Principles of Genetics	3

Supporting Sciences: 15 cr.

Courses cannot be used to fulfill any other university, college or Agronomy requirements. At least 9 cr. must be in courses numbered 300 or above.

This requirement can be met in one of three ways:

- Complete at least 3 credits in basic or mathematics-intensive discipline (ACCT, BBMB, BIOL, CHEM, COM S, ECON, All Engineering, GEOL, GEN, MATH, MTEOR, PHYS, STAT) as well as at least 6 additional credits in BIOL, BBMB, ENSCI, ENT, GEOL, HORT, GEN, MICRO, NREM, PL P, TSM. The other 6 credits can be a combination of the above department's courses and/or AGRON.
- Complete the courses needed to fulfill a second major that complements the student's academic and professional goals.
- By the end of the third semester before graduation, petition the Agronomy Curriculum Committee with a specific set of courses designed around "keeper of the land", "builder of genetic diversity", "explorer of plant life", "developer of bio-energy", "confronter of world hunger", "designer of sustainable systems".

Agronomy Core: 47 cr.

AGRON 105	Leadership Experience	R
AGRON 110	Professional Development in Agronomy: Orientation	1
AGRON 180	Global Agriculture in a Changing World	3
AGRON 181	Introduction to Crop Science	3
AGRON 182	Introduction to Soil Science	3
AGRON 183	Basic Skills for Agronomists	1
AGRON 206	Introduction to Weather and Climate	3
AGRON 210	Professional Development in Agronomy: Career Planning	1
AGRON 279	Field Exploration of Agronomy	3
AGRON 280	Crop Development, Production and Management	3
AGRON 281	Crop Physiology	3
AGRON 282	Soil Conservation and Land Use	3
AGRON 310	Professional Development in Agronomy: Work Experience	R
	or AGRON 311 Professional Internship in Agronomy	
AGRON 316	Crop Structure-Function Relationships	3
AGRON 342	World Food Issues: Past and Present	3
	or AGRON 450 Issues in Sustainable Agriculture	
AGRON 354 & 354L	Soils and Plant Growth and Soils and Plant Growth Laboratory	4
AGRON 360	Environmental Soil Science	3
	or AGRON 392 Systems Analysis in Crop and Soil Management	
AGRON 410	Professional Development in Agronomy: Senior Forum	1
Additional AGRON credits at the 300-400 level		6

Electives: 17 cr.

Additional free electives 17

Agronomy, B.S.

Freshman

Fall	Credits Spring	Credits
AGRON 110	1 AGRON 181	3
AGRON 180	3 AGRON 182	3
AGRON 183	1 BIOL 212	3
CHEM 163 & Lab or CHEM 177 & Lab	5 BIOL 212L	1
ENGL 150	3 ENGL 250	3
LIB 160	1 Math or Social Sciences	3
Math or Social Sciences	3	
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17		16

Sophomore

Fall	Credits Spring	Credits
AGRON 206	3 AGRON 281	3
AGRON 210	1 AGRON 282	3
AGRON 279	3 AGEDS 311 or SP CM 212	3
AGRON 280	3 Organic Chemistry: AGRON 259, BBMB 221, OR CHEM 231 & L	3-4
STAT 104	3 Elective	3
Humanities	3	
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16		15-16

Junior

Fall	Credits Spring	Credits
AGRON 354	3 AGRON 316	3
AGRON 354L	1 AGRON 320 or BIOL 313	3-4
AGRON 342 or AGRON 450	3 ENGL 302, 309, or 314	3
Elective	3 International Perspectives	3
Supporting Sciences	6 Supporting Sciences	3
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16		15-16

Senior

Fall	Credits Spring	Credits
Agronomy Electives	6 AGRON 360 OR AGRON 392	3
Elective	6 AGRON 410	1
Ethics	3 Elective	5
U.S. Diversity	3 Supporting Sciences	6
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18		15

Minor - Agronomy

A minor in agronomy is earned by taking 18 credits, 9 credits of which must be from foundational courses. An additional 9 credits must be taken from foundational or approved elective courses, with a minimum of 6 of the 9 credits from courses at the 300 level or higher. At least 9 credits must be taken at Iowa State University with 6 credits numbered 300 or above. At least 9 credits must be unique to the requirements for the minor and not used to fulfill specified requirements from the student's major.

Foundational Courses (9 required credits):

AGRON 180	Global Agriculture in a Changing World	3
AGRON 181	Introduction to Crop Science	3
AGRON 182	Introduction to Soil Science	3
AGRON 280	Crop Development, Production and Management	3
AGRON 281	Crop Physiology	3
AGRON 282	Soil Conservation and Land Use	3
Approved Elective Courses for Minor Credit (9 credits minimum, 6 credits at 300+ level)		
AGRON 206	Introduction to Weather and Climate	3
AGRON 217	Weed Identification	1
AGRON 259	Organic Compounds in Plants and Soils	3
AGRON 316	Crop Structure-Function Relationships	3
AGRON 317	Principles of Weed Science	3
AGRON 320	Genetics, Agriculture and Biotechnology	3
AGRON 330	Crop and Seed Identification Laboratory	2
AGRON 334	Forage Crop Management	3
AGRON 338	Seed Science and Technology	3
AGRON 342	World Food Issues: Past and Present	3
AGRON 351	Turfgrass Establishment and Management	3
AGRON 354	Soils and Plant Growth	3
AGRON 354L	Soils and Plant Growth Laboratory	1
AGRON 360	Environmental Soil Science	3
AGRON 392	Systems Analysis in Crop and Soil Management	3
ENSCI 402	Watershed Hydrology	3
AGRON 404	Global Change	3
AGRON 405	Environmental Biophysics	3
AGRON 406	World Climates	3
AGRON 407	Mesoscale Meteorology	3
AGRON 421	Introduction to Plant Breeding	3
AGRON 446	International Issues and Challenges in Sustainable Development	3
AGRON 450	Issues in Sustainable Agriculture	3
AGRON 452	GIS for Geoscientists	3

AGRON 459	Environmental Soil and Water Chemistry	4
AGRON 463	Soil Formation and Landscape Relationships	3
AGRON 477	Soil Physics	3
AGRON 484	Organic Agricultural Theory and Practice	3
AGRON 485	Soil and Environmental Microbiology	3
AGRON 497	Agroecology Field Course	3

Students minoring in agronomy can take the following courses:

AGRON 331, AGRON 370, AGRON 490, and AGRON 496; but only one (1) credit from these courses can be used in the minor program

Graduate Study Introduction

Agronomy is the science and technology of producing plants that serve humans, using practices essential for maintaining and improving life. The Department of Agronomy administers Master of Science (MS) and Doctor of Philosophy (PhD) degree programs in four different graduate majors that emphasize different disciplines of agronomy. These majors are: Agricultural Meteorology; Crop Production and Physiology; Plant Breeding; and Soil Science. A fifth graduate major, Agronomy, offers both an MS and a Graduate Certificate through distance education suitable for professionals working in industry or government, as well as a graduate minor for on-campus students.

Admission

To be fully admitted, prospective graduate students must have an undergraduate GPA of at least a 3.00 GPA (4.00 scale) or rank in the upper one-half of their undergraduate class. Provisional and restricted admission demand that students fulfill certain requirements. Non-native English speakers must take the Test of English as a Foreign Language (TOEFL). Students applying to the Agricultural Meteorology and Plant Breeding graduate majors must take the Graduate Record Examination (GRE). For all of the majors except Agronomy, a faculty member of the graduate major must agree to be the major professor before the student is admitted.

Program of Study

The academic courses used to satisfy requirements for a graduate degree compose a student's Program of Study (POS). The POS must be approved by the student's POS Committee. For the MS in Agronomy, the POS Committee must be composed of at least two faculty who are both members of the Graduate Major in Agronomy. For the other four majors at the MS degree level, at least three faculty must serve on a POS Committee. Two of the three must be members of the major, and at least one must be a member of a different graduate major. At the PhD level the POS Committee must have at least five members, of which at least three must be faculty in the major, and at least one a member of a different graduate major. If the student is pursuing a graduate minor, either as

part of an MS or PhD, a graduate faculty member representing the minor must serve on the POS Committee.

Agronomy

The POS for the MS in Agronomy is fixed and consists of the following:

AGRON 501	Crop Growth and Development	3
AGRON 502	Chemistry, Physics, and Biology of Soils	3
AGRON 503	Climate and Crop Growth	3
AGRON 511	Crop Improvement	3
AGRON 512	Soil-Plant Environment	3
AGRON 513	Quantitative Methods for Agronomy	3
AGRON 514	Integrated Pest Management	3
AGRON 531	Crop Ecology and Management	3
AGRON 532	Soil Management	3
AGRON 533	Crop Protection	3
AGRON 591	Agronomic Systems Analysis	3
AGRON 592	Current Issues in Agronomy	3
AGRON 594	Agronomy MS Practicum	1
AGRON 599M	Agronomy	arr †

† Arranged with instructor.

All Other Degrees

The courses in each student's POS will vary depending on the major and the student's interests. Every on-campus student must include AGRON 601 in their POS. Note that only a maximum of three 400-level courses or up to one 300-level and two 400-level courses may be included on the POS. If a 300-level course is listed on the POS it cannot be an AGRON course.

Agricultural Meteorology

Students with a major in Agricultural Meteorology must include AGRON 698 in their POS. Students are encouraged to include the following courses: AGRON 505; AGRON 577; MTEOR 605; a modeling course such as AGRON 508, AGRON 518, AGRON 525, AGRON 677, GEOL 516, or MTEOR 552; and a course in statistics.

Crop Production and Physiology

The Graduate Major in Crop Production and Physiology has defined five Core Areas.

Core Area 1 (molecular biology / biochemistry): BBMB 404, BBMB 405, BBMB 542A–G, BBMB 607, and PLBIO 545.

Core Area 2 (growth and development): AGRON525, AGRON551, BIOL 454, BIOL 428, and GDCB 528.

Core Area 3 (plant physiology and metabolism): AGRON508, AGRON516, AGRON519, AGRON 525, AGRON 538, AGRON 553, AGRON 556, BBMB 645, and PLBIO 513.

Core Area 4 (crop ecology and management): AGRON 509, AGRON 515, AGRON 530, AGRON 553, AGRON 556, BIOL 472, BIOL 474, EEOB 570, EEOB 582, EEOB 584, EEOB 589, HORT 524, PL P 577, and PL P 594.

Core Area 5 (statistics / quantitative methods): AGRON 526, STAT 401, STAT 402, STAT 407, STAT 505, STAT 512, CRP 551, and NREM 546.

To major in Crop Production and Physiology, at least one course from three of the Core Areas must be included in the POS for the MS. For the PhD, at least one course from each of the Core Areas must be included. A single course cannot be used for more than one Core Area. Students are also encouraged to consider AGRON 698.

Plant Breeding

The Graduate Major in Plant Breeding has both a resident and distance-education MS program. The following courses are recommended for students with a major in Plant Breeding: AGRON 521, AGRON 522, AGRON 523, AGRON 524, AGRON 528, AGRON 561, AGRON 600A, AGRON 698, GEN 510, STAT 401, and STAT 402. For the distance program, the following courses are recommended: AGRON 501, AGRON 506, AGRON 513, AGRON 520, AGRON 521, AGRON 523, AGRON 524, AGRON 528, AGRON 544, and AGRON 599. Resident students pursuing the PhD also often include AGRON 621 and AGRON 625 in their POS.

Soil Science

Students pursuing a major in Soil Science may specialize in one of six areas: soil chemistry; soil fertility; soil management; soil microbiology and biochemistry; soil morphology and genesis; or soil physics. If a specialization is chosen, the major professor must be in the designated specialty area. For the PhD, the POS must include one credit of AGRON 600B. Students are also encouraged to consider including AGRON 698 in their POS.

Master of Science

The general requirements for an MS degree include:

- a minimum of 30 credits from academic courses and research activities;
- at least 22 credits earned at ISU;
- two-thirds or more of earned credits related to the major; and
- completion of a final oral examination.

Both non-thesis and thesis options for an MS degree in Agricultural Meteorology, Crop Production and Physiology, Plant Breeding, and Soil Science are available. Students in the Agronomy major must choose the non-thesis option.

Students in Agricultural Meteorology working towards the MS must meet with their POS Committee at least twice. Besides the final oral examination, an additional meeting must be held near the beginning of the graduate program. At this meeting the student will introduce the area of research to be pursued, potential research questions and

methods, and a proposed POS. The student must also present a short written report on how the proposed research will help them master established Enduring Understandings in Agricultural Meteorology.

Creative Component

If the non-thesis MS degree is chosen, then the student must:

1. register for at least two credits of AGRON 599 that will be used to complete a “creative component;” and
2. pass a comprehensive final oral examination.

The creative component is work that presents “substantial evidence of individual accomplishment.” The POS Committee and the student will specify the creative component, how it will be documented, and how it will be evaluated. The POS Committee also has flexibility in determining the format of the final oral examination. For Agricultural Meteorology, the final oral exam must include an evaluation of the student’s mastery of the Enduring Understandings in Agricultural Meteorology.

Thesis

In the thesis option the student must:

1. pursue a research project culminating in a written thesis; and
2. pass a comprehensive final oral examination.

A minimum of three research credits of AGRON 699 must be listed on the POS to account for work on an MS thesis. The thesis is submitted to the POS Committee prior to the final oral examination. During the final oral examination, the student will present and defend the thesis in the presence of the POS Committee. Students in Agricultural Meteorology must also demonstrate mastery of the Enduring Understandings in Agricultural Meteorology. The presentation (also called the “exit seminar”) is open to the general public. Only POS Committee members may attend the examination that follows the presentation.

Doctor of Philosophy

The general requirements for a PhD degree include:

- a minimum of 72 credits from academic courses and research activities;
- at least 36 of these credits earned at ISU;
- completion of a preliminary oral examination;
- a written PhD dissertation; and
- completion of a comprehensive final oral examination.

Note that the 72 credits can include the credits earned in pursuit of an MS degree. If an MS was earned at another institution, those courses earned at the other institution can be listed along with the ISU courses, but only if the POS Committee determines that the courses are appropriate. Students in Agricultural Meteorology working towards the PhD must meet with their POS Committee at least three times. Besides the final oral examination and another for the preliminary exam, an additional meeting must be held near the beginning of the graduate

program. At this meeting the student will introduce the area of research to be pursued, potential research questions and methods, and a proposed POS. If a student will pursue a PhD without first completing an MS, then during the first meeting of the POS Committee the student must also present a short written report that illustrates connections between the Enduring Understandings in Agricultural Meteorology and their planned research.

Qualification Exam

Agricultural Meteorology

Students in Agricultural Meteorology must take and pass a qualification exam once they have decided to pursue a PhD. The qualification exam must be passed before taking the preliminary exam. The format of the qualification exam is as follows. The student will produce a written report that demonstrates their knowledge of the Enduring Understandings in Agricultural Meteorology. If the student has come from another university the report must present research completed at ISU and not at the previous institution (such as a thesis). This report will be submitted to all of the faculty in the major. The student will then make an oral presentation to faculty and other students in the major that summarizes and defends the written report. After the oral presentation, the faculty will meet to determine whether or not the student passed the exam, and whether the student can re-take the exam if the student failed. The faculty will provide written feedback to the student, suggesting areas where improvement is needed and a course of action. The qualification exam can be taken only two times during a student’s graduate career at ISU. If a student who had entered the PhD program without an MS degree takes the qualification exam and fails the exam, the student can: take the qualification exam again, if so allowed by the faculty; or continue their graduate career in pursuit of an MS degree. In the latter case, the student could take the qualification exam one more time after an MS degree has been completed.

All Other Majors

A qualification exam is not required for students in the Crop Production and Physiology, Plant Breeding, or Soil Science majors.

Preliminary Exam

All students pursuing a PhD must take and pass a preliminary oral examination.

Agricultural Meteorology

For students in Agricultural Meteorology the preliminary exam consists of a defense of the student’s proposed dissertation research to the POS Committee. Besides an oral defense, the student must also submit a written report on their proposed research. If the student fails the preliminary exam, the POS Committee must also decide if the student can re-take the exam. The preliminary exam can only be taken twice.

Crop Production and Physiology

Students in Crop Production and Physiology may be asked to take a written preliminary examination. If a student fails the written preliminary examination, the POS Committee may require the student to retake the exam, to answer additional written questions, or proceed with the oral examination. The nature of the preliminary oral exam is determined by the student's POS Committee.

Plant Breeding

Students in Plant Breeding must pass a uniform written preliminary examination that consists of five questions, each from one of five topical areas. Faculty members in Plant Breeding evaluate each answer. Evaluators assign a pass or fail grade to the answer. If an evaluator assigns a failing grade to a question, the evaluator shall clearly indicate the strengths and weaknesses of the answer and provide written information (e.g., references, rationale) to the student which clearly outlines an acceptable response to the question. Failure to provide such written information may invalidate that grade and be considered sufficient cause to exclude the grade in the overall evaluation of the student's answer. Students who receive two pass grades for a question will have successfully completed that topic, and students must pass each topic to pass the exam. If two valid grades are not in agreement (e.g., one passing grade and one failing grade), additional faculty members will evaluate the answer until there are two valid assessments that are in agreement. Students who do not pass a topic have the opportunity to repeat that topic on the next regularly scheduled exam date. The number of attempts for each topic has not been specified. The examination is offered the last Thursday and Friday of each January and September when one or more students have signed up to take the exam. Students may choose to attempt questions for all five topics, or for subsets of the topics. If a student decides to attempt questions for only certain topics, the student must specify which topics in writing at least one month prior to the scheduled exam date. The nature of the preliminary oral exam is determined by the student's POS Committee.

Soil Science

Students in Soil Science must pass a written preliminary examination. Exam questions are authored by members of the POS Committee. The format of each question is left open and they may be formulated as open- or closed-book problems. A reasonable period for completion may be set by the author of the question. The student's responses are formally scored or ranked only by the POS Committee member who authored the question. A copy of the student's responses to all questions is submitted to all POS Committee members at least one week before the student's preliminary oral examination. When the student submits a request to schedule the preliminary oral examination, the student's major professor certifies by signing the form that the student has satisfactorily completed a written preliminary exam. The nature of the preliminary oral exam is determined by the student's POS Committee.

Doctoral Dissertation and Final Oral Examination

All students must include at least three AGRON 699 credits in their POS for work on their PhD dissertation. During the required final oral examination, a student presents and defends the dissertation. This presentation (also called the "exit seminar") is open to the general public. Only POS Committee members may attend the examination that follows the presentation.

Graduate Certificate in Agronomy for distance students

The Graduate Certificate in Agronomy is for distance students and is comprised of the first six courses in the Master of Science in Agronomy Distance Curriculum. All six courses are required for certificate completion.

AGRON 501	Crop Growth and Development	3
AGRON 502	Chemistry, Physics, and Biology of Soils	3
AGRON 503	Climate and Crop Growth	3
AGRON 511	Crop Improvement	3
AGRON 512	Soil-Plant Environment	3
AGRON 514	Integrated Pest Management	3
Total Credits		18

Graduate Minor

Students who wish to minor in Agronomy must include a core course from each of the other four graduate majors in their POS. These courses are:

AGRON 505	Environmental Biophysics	3
AGRON 516	Crop Physiology	3
AGRON 521	Principles of Cultivar Development	3
AGRON 553	Soil-Plant Relationships	3

However, one substitution is allowed with the approval of the faculty member serving as the minor representative on the POS Committee.

Courses primarily for undergraduates:

AGRON 105: Leadership Experience

Cr. R. F.S.SS.

A participatory experience in activities or completion of a course that enhances the development of leadership and group-dynamic skills. See adviser for departmental requirements.

AGRON 110: Professional Development in Agronomy: Orientation

Cr. 1. F.

Orientation to college life, the profession of agronomy, and the agronomy curriculum.

AGRON 120: Introduction to Renewable Resources

(Cross-listed with ENV S, NREM). (3-0) Cr. 3. F.S.

Overview of soil, water, plants, and animals as renewable natural resources in an ecosystem context. History and organization of resource management. Concepts of integrated resource management.

AGRON 160: Water Resources of the World

(Cross-listed with ENV S, GEOL, MTEOR). (3-0) Cr. 3. S.

Study of the occurrence, history, development, and management of world water resources. Basic hydrologic principles including climate, surface water, groundwater, and water quality. Historical and current perspectives on water policy, use, and the role of water in society and the environment. Meets International Perspectives Requirement.

AGRON 180: Global Agriculture in a Changing World

(3-0) Cr. 3. F.

A scientific investigation of the global distribution of climate, soils and agricultural production and consumption. Physical processes that connect natural resources to agriculture and the environment. How global change drives increasing demand for agricultural production. Meets International Perspectives Requirement.

AGRON 181: Introduction to Crop Science

(3-0) Cr. 3. F.S.

Basic structure and function of plants, origin and classification, growth and development. Fundamentals of photosynthesis, plant water use, plant nutrition and genetics that regulate plant growth, development and responses to the environment.

AGRON 182: Introduction to Soil Science

(3-0) Cr. 3. F.S.

Prereq: Chem 163

Introduction to physical, chemical, and biological properties of soils; soil formation, classification and global distribution; soil health, soils and humanity and sustainable land management.

AGRON 183: Basic Skills for Agronomists

(0-3) Cr. 1. F.

Developing the skills that agronomists employ in their work with crops, soil, and the environment through activities involving tools and methodologies used by agronomists. Enrollment is restricted to first-year students majoring in agronomy.

AGRON 206: Introduction to Weather and Climate

(Cross-listed with MTEOR). (3-0) Cr. 3. F.S.

Basic concepts in weather and climate, including atmospheric measurements, radiation, stability, precipitation, winds, fronts, forecasting, and severe weather. Applied topics include global warming, ozone depletion, world climates and weather safety.

AGRON 210: Professional Development in Agronomy: Career Planning

(1-0) Cr. 1. F.

Prereq: Sophomore classification

Career planning, résumé and cover letter preparation, and interviewing techniques. Career orientation through invited speakers.

AGRON 217: Weed Identification

(1-2) Cr. 1. F.S.

Prereq: BIOL 101 or equivalent

Half-semester course. Identification of important weeds of agricultural, horticultural and native ecosystems. Principles of plant taxonomy and classification. Field trips.

AGRON 259: Organic Compounds in Plants and Soils

(3-0) Cr. 3. S.

Prereq: CHEM 163, BIOL 212, MATH 140, AGRON 182

Structure, function, and transformations of organic compounds significant in plant and soil environments.

AGRON 279: Field Exploration of Agronomy

(2-3) Cr. 3. F.

Prereq: AGRON 181 or equivalent and AGRON 182 or equivalent

Field-based investigation of Iowa's agronomic systems. Application of principles learned in introductory soils, crops and agronomy courses. For students majoring in Agronomy.

AGRON 280: Crop Development, Production and Management

(3-0) Cr. 3. F.S.

Prereq: AGRON 181 or equivalent and AGRON 182 or equivalent

Overview of crops and cropping systems in the context of global and US agriculture. Focus on agronomic principles, constraints and opportunities as they apply to various locations in Iowa, the USA and the world.

AGRON 281: Crop Physiology

(3-0) Cr. 3. S.

Prereq: Agron 181 or equivalent

Science governing plant growth and development in the context of cropping and genetic improvements.

AGRON 282: Soil Conservation and Land Use

(3-0) Cr. 3. F.S.

Prereq: Agron 182 or equivalent

Principles of soil conservation and land use with emphasis on best management practices and use of soil maps and databases such as Web Soil Survey.

AGRON 283: Pesticide Application Certification

(Cross-listed with ENT, FOR, HORT). (2-0) Cr. 2. S.

Core background and specialty topics in agricultural, and horticultural pesticide applicator certification. Students can select certification categories and have the opportunity to obtain pesticide applicator certification at the completion of the course. Commercial pesticide applicator certification is emphasized.

AGRON 298: Cooperative Education

Cr. R. F.S.SS.

Prereq: Permission of faculty member or student's adviser, sophomore classification

Students register for this course in order to retain full-time status while on a professional work experience. Students must register for this course prior to commencing each work period. Offered on a satisfactory-fail basis only.

AGRON 310: Professional Development in Agronomy: Work Experience

Cr. R. F.S.SS.

Professional work experience in agronomy. See adviser for departmental requirements. Offered on a satisfactory-fail basis only.

AGRON 311: Professional Internship in Agronomy

(1-0) Cr. 1. F.

Prereq: Permission of adviser

A supervised learning experience in a professional setting related to crop production, plant breeding, soil science or environmental science. For students majoring in Agronomy.

AGRON 316: Crop Structure-Function Relationships

(3-0) Cr. 3. F.S.

Prereq: BIOL 212 recommended

Basic principles concerning the growth, development, and production of crop communities in relation to their environment.

AGRON 317: Principles of Weed Science

(3-0) Cr. 3. F.

Biology and ecology of weeds. Interactions between weeds and crops. Principles and practices of integrated weed management systems. Herbicide mechanisms, classification, and fate in plants and soils.

AGRON 320: Genetics, Agriculture and Biotechnology

(Cross-listed with GEN). (3-0) Cr. 3. F.S.

Prereq: BIOL 212

Transmission and molecular genetics with an emphasis on applications in agriculture, the structure and expression of the gene, how genes behave in populations and how recombinant DNA technology can be used to improve agriculture. Credit for graduation will not be allowed for more than one of the following: Gen 260, 313, 320 and Biol 313 and 313L.

AGRON 330: Crop and Seed Identification Laboratory

(0-4) Cr. 2. F.

Prereq: AGRON 181 or equivalent.

Identification, agronomic and binomial classification of crops, weeds, and diseases. Analysis of crop seed samples for contaminants of weed and other crop seeds.

AGRON 331: Intercollegiate Crops Team

(0-6) Cr. 2. Repeatable. F.S.

Prereq: Permission of instructor. AGRON 330 recommended

Intensive training in preparation for intercollegiate competition in national crops contests.

AGRON 334: Forage Crop Management

(3-0) Cr. 3. S.

Prereq: AGRON 181 or equivalent

Production and management of forage crops; concepts applied to yield, quality, and stand persistence; systems of forage utilization including grazing, hay, and silage. Students enrolling for graduate credit will be expected to complete an additional class project.

AGRON 338: Seed Science and Technology

(Cross-listed with HORT). (2-3) Cr. 3. F.

Prereq: AGRON 181 (or equivalent) or HORT 221; BIOL 212

Seed production, maturation, dormancy, vigor, deterioration, and related aspects of enhancement, conditioning, storage, and quality evaluation. Aspects of the seed industry and regulation of seed marketing.

AGRON 342: World Food Issues: Past and Present

(Cross-listed with ENV S, FS HN). (3-0) Cr. 3. F.S.SS.

Prereq: Junior classification

Issues associated with global agricultural and food systems including ethical, social, economic, environmental, and policy contexts. Investigation of various causes and consequences of overnutrition/undernutrition, poverty, hunger, access, and distribution. Meets International Perspectives Requirement.

AGRON 342H: World Food Issues: Past and Present, Honors

(Cross-listed with ENV S). (3-0) Cr. 3. F.S.

Prereq: Junior classification

Issues in the agricultural and food systems of the developed and developing world. Emphasis on economic, social, historical, ethical and environmental contexts. Causes and consequences of overnutrition/undernutrition, poverty, hunger and access/distribution. Explorations of current issues and ideas for the future. Team projects. Meets International Perspectives Requirement.

AGRON 351: Turfgrass Establishment and Management

(Cross-listed with HORT). (3-0) Cr. 3. F.

Prereq: HORT 221 or AGRON 181 (or equivalent) or BIOL 211

Principles and practices of turfgrass propagation, establishment, and management. Specialized practices relative to professional lawn care, golf courses, athletic fields, highway roadsides, and seed and sod production. The biology and control of turfgrass pests.

AGRON 351L: Turfgrass Establishment and Management Laboratory

(Cross-listed with HORT). (0-3) Cr. 1. F.

Prereq: Credit or enrollment in HORT 351

Those enrolled in the horticulture curriculum are required to take 351L in conjunction with 351 except by permission of the instructor.

AGRON 354: Soils and Plant Growth

(Cross-listed with HORT). (3-0) Cr. 3. F.S.

Prereq: AGRON 182 or equivalent and BIOL 101

Effects of chemical, physical, and biological properties of soils on plant growth, with emphasis on nutritive elements, pH, organic matter maintenance, and rooting development.

AGRON 354L: Soils and Plant Growth Laboratory

(Cross-listed with HORT). (0-3) Cr. 1. F.S.

Prereq: Agron or Hort major with credit or enrollment in AGRON 354

Laboratory exercises in soil testing that assess a soil's ability to support nutritive requirements for plant growth.

AGRON 360: Environmental Soil Science

(Cross-listed with ENSCI). (2-2) Cr. 3. S.

Prereq: AGRON 182 (or equivalent) or ENSCI 250 or GEOL 201

Application of soil science to contemporary environmental problems; comparison of the impacts that different management strategies have on short- and long-term environmental quality and land development. Emphasis on participatory learning activities.

AGRON 370: Field Experience in Soil Description and Interpretation

(0-3) Cr. 1. Repeatable, maximum of 4 times. F.S.

Prereq: AGRON 182 or equivalent and permission of instructor

Description and interpretation of soils in the field and laboratory, emphasizing hands-on experience. Evaluation of soil information for land use. Students may participate in intercollegiate judging contests.

AGRON 388: Agronomic Sciences in Theory and Practice

(1-0) Cr. 1. F.

Prereq: Junior or senior classification

How science works: Hypotheses, data integrity, classification, interpretations, ethics, and communications.

AGRON 392: Systems Analysis in Crop and Soil Management

(2-3) Cr. 3. F.S.

Prereq: AGRON 316 and AGRON 354

Management strategies at the level of the farm field. Emphasis will be on participatory learning activities.

AGRON 398: Cooperative Education

Cr. R. F.S.SS.

Prereq: Permission of faculty member or student's adviser; junior classification

Student register for this course in order to retain full-time status while on a professional work experience. The student must register for this course prior to commencing each work period. Offered on a satisfactory-fail basis only.

AGRON 402I: Watershed Hydrology and Surficial Processes

(Cross-listed with ENSCI, IA LL). Cr. 4. SS.

Prereq: Four courses in physical or biological sciences or engineering

Effects of geomorphology, soils, and land use on transport of water and materials (nutrients, contaminants) in watersheds. Fieldwork will emphasize investigations of the Iowa Great Lakes watershed.

AGRON 404: Global Change

(Dual-listed with AGRON 504). (Cross-listed with ENSCI, ENV S, MTEOR).

(3-0) Cr. 3. S.

Prereq: Four courses in physical or biological sciences or engineering; junior standing

Recent changes in global biogeochemical cycles and climate; models of future changes in the climate system; impacts of global change on agriculture, water resources and human health; ethical issues of global environmental change. Also offered online Alt. F, even-numbered years.

AGRON 405: Environmental Biophysics

(Dual-listed with AGRON 505). (Cross-listed with ENSCI, MTEOR). (3-0) Cr.

3. Alt. S., offered odd-numbered years.

Prereq: MATH 165 and some exposure to computer programming (any language)

The movement of energy and mass among the soil, vegetation, and atmosphere. The heat and water budget of humans, other animals, plants, and plant communities. Relevance to weather and climate, the effect of climate change on organisms, and remote sensing.

AGRON 406: World Climates

(Cross-listed with ENSCI, MTEOR). (3-0) Cr. 3. S.

Prereq: AGRON 206/MTEOR 206

Distribution and causes of different climates around the world. Effects of climate and climate variations on human activities including society, economy and agriculture. Current issues such as climate change and international efforts to assess and mitigate the consequences of a changing climate. Semester project and in-class presentation required. Meets International Perspectives Requirement.

AGRON 407: Mesoscale Meteorology

(Dual-listed with AGRON 507). (Cross-listed with MTEOR). (3-0) Cr. 3. Alt. S., offered even-numbered years.

Prereq: Math 166 and Mteor 443

Arritt, Gallus. Physical nature and practical consequences of mesoscale atmospheric phenomena. Mesoscale convective systems, fronts, terrain-forced circulations. Observation, analysis, and prediction of mesoscale atmospheric structure.

AGRON 410: Professional Development in Agronomy: Senior Forum

(1-0) Cr. 1. F.S.

Prereq: Senior classification, AGRON 210

Development of an appropriate content for professionalism. Topics include professional certification, ethics, and maintaining an active network of information sources and professional contacts in support of lifelong learning. Student interpretation, writings, presentations, and discussions.

AGRON 421: Introduction to Plant Breeding

(Cross-listed with HORT). (3-0) Cr. 3. F.

Prereq: GEN 320 or BIOL 313

Fundamental principles of plant breeding and cultivar development, breeding methods for self-pollinated, cross-pollinated and clonal crops.

AGRON 446: International Issues and Challenges in Sustainable Development

(Cross-listed with GLOBE, INTST). Cr. 3. F.S.

Prereq: 3-credit biology course, Sophomore or higher classification, permission of Instructor

Interdisciplinary study and analysis of agricultural systems, sustainable management, and impact on plants and animal biodiversity. International field experience in evaluating different agricultural systems and impact on biodiversity may be required. A program fee is charged to students for international study abroad.

Meets International Perspectives Requirement.

AGRON 450: Issues in Sustainable Agriculture

(Cross-listed with ENV S). (3-0) Cr. 3. F.

Agricultural science as a human activity; contemporary agricultural issues from agroecological perspective. Comparative analysis of intended and actual consequences of development of industrial agricultural practices.

AGRON 452: GIS for Geoscientists

(Dual-listed with AGRON 552). (Cross-listed with ENSCI, GEOL). (2-2) Cr. 3. F.S.

Prereq: GEOL 100, GEOL 201 or equivalent

Introduction to geographic information systems (GIS) with particular emphasis on geoscientific data. Uses ESRI's ArcGIS Desktop Software and extension modules. Emphasizes typical GIS operations and analyses in the geosciences to prepare students for advanced GIS courses.

AGRON 459: Environmental Soil and Water Chemistry

(Dual-listed with AGRON 559). (Cross-listed with ENSCI). (3-3) Cr. 4. F.

Prereq: Two semesters of college-level chemistry, MATH 140, AGRON 182 (or equivalent) or AGRON 360; GEOL 100 and AGRON 354 recommended

An introduction to the chemical properties of soils, chemical reactions and transformations in soils and surface waters, and their impact on the environment. Topics include solution chemistry in soils and surface waters, solid-phase composition of soils, reactions at the solid-solution interface, and applications to contemporary environmental issues.

AGRON 463: Soil Formation and Landscape Relationships

(Dual-listed with AGRON 563). (Cross-listed with ENSCI). (3-0) Cr. 3. S.

Prereq: AGRON 182 (or equivalent) or AGRON 260

Relationships between soil formation, geomorphology, and environment. Soil description, classification, geography, mapping, and interpretation for land use. Two weekend field trips. Credit for one of AGRON 463 or AGRON 463I may be applied for graduation.

AGRON 463I: Soil Formation and Landscape Relationships

(Dual-listed with AGRON 563I). (Cross-listed with ENSCI, IA LL). Cr. 2. Alt. SS., offered even-numbered years.

Prereq: AGRON 182 (or equivalent)

Relationships between soil formation, geomorphology, and environment. Soil description, classification, geography, mapping, and interpretation for land use. Credit for only Agron 563 or 563I may be applied for graduation.

AGRON 463L: Soil Formation and Landscape Relationships Laboratory

(0-3) Cr. 1. S.

Prereq: Credit or enrollment in Agron 463

Laboratory exercise in soil formation with landscape relationships including pedon description with soil mapping.

AGRON 477: Soil Physics

(Dual-listed with AGRON 577). (Cross-listed with ENSCI). (3-0) Cr. 3. S.

Prereq: AGRON 182 or equivalent and MATH 166 recommended

The physical soil system: the soil components and their physical interactions; transport processes involving water, air, and heat.

AGRON 484: Organic Agricultural Theory and Practice

(Dual-listed with AGRON 584). (Cross-listed with HORT). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: 9 cr. in biological or physical sciences

Understanding of the historical origins and ecological theories

underpinning the practices involved in organic agriculture.

Interdisciplinary examination of crop and livestock production and socio-economic processes and policies in organic agriculture from researcher and producer perspectives.

AGRON 485: Soil and Environmental Microbiology

(Dual-listed with AGRON 585). (Cross-listed with ENSCI, MICRO). (2-3) Cr. 3. F.

Prereq: AGRON 182 or equivalent; MICRO 201 and MICRO 201L recommended

The living organisms in the soil and what they do. Emphasis on soil biota composition, the carbon cycle and bioremediation, soil-plant-microbial relationships, and environmental issues.

AGRON 488: GIS for Geoscientists II

(Dual-listed with AGRON 588). (Cross-listed with ENSCI, GEOL). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: GIS course, such as GEOL 452, CRP 451, CRP 452, NREM 345, NREM 446, AE 408 or equivalent

GIS course with focus on the spatial analysis and modeling of raster data and triangulated irregular network (TIN) data. Uses ArcGIS and various extensions, such as Spatial Analyst, 3D Analyst, and ArcScene. Includes practical exercises during lectures, lab exercises, homework assignments, and (for GEOL 588) a class project.

AGRON 490: Independent Study

Cr. 1-3. Repeatable, maximum of 4 credits. F.S.SS.

Prereq: Junior or senior classification with at least 8 credits in agronomy; permission of instructor in specialty area after consultation

Selected studies in crops, soils, or agricultural meteorology according to the needs and interests of the student.

AGRON 490E: Independent Study: Entrepreneurship

Cr. 1-3. Repeatable, maximum of 4 credits. F.S.SS.

Prereq: Junior or senior classification with at least 8 credits in agronomy; permission of instructor in specialty area after consultation

Selected studies in crops, soils, or agricultural meteorology according to the needs and interests of the student.

AGRON 490G: Independent Study: General

Cr. 1-3. Repeatable, maximum of 4 credits. F.S.SS.

Prereq: Junior or senior classification with at least 8 credits in agronomy; permission of instructor in specialty area after consultation

Selected studies in crops, soils, or agricultural meteorology according to the needs and interests of the student.

AGRON 490H: Independent Study: Honors

Cr. 1-3. Repeatable, maximum of 4 credits. F.S.SS.

Prereq: Junior or senior classification with at least 8 credits in agronomy; permission of instructor in specialty area after consultation

Selected studies in crops, soils, or agricultural meteorology according to the needs and interests of the student.

AGRON 490Z: Independent Study: Service Learning

Cr. 1-3. Repeatable, maximum of 4 credits. F.S.SS.

Prereq: Junior or senior classification with at least 8 credits in agronomy; permission of instructor in specialty area after consultation

Selected studies in crops, soils, or agricultural meteorology according to the needs and interests of the student.

AGRON 491: Seed Science Internship Experience

(Cross-listed with HORT). Cr. 1-2. Repeatable, maximum of 1 times. F.S.SS.

Prereq: Agron 338, advanced approval and participation of employer and instructor

A professional work experience and creative project for seed science secondary majors. The project requires the prior approval and participation of the employer and instructor. The student must submit a written report.

AGRON 493: Workshop in Agronomy

Cr. arr. Repeatable, maximum of 4 times.

Prereq: Permission of instructor

Workshop experience in crops, soils, or agricultural meteorology.

AGRON 496: Agricultural Travel Course

Cr. arr. Repeatable.

Prereq: Permission of instructor

Limited enrollment. Tour and study of production methods in major crop and livestock regions of the world. Influence of climate, economics, geography, soils, landscapes, markets, and other factors on crop and livestock production. Location and duration of tours will vary. Tour expenses paid by students. Check with department for current offerings.

AGRON 496A: International Tour

Cr. arr. Repeatable.

Prereq: Permission of instructor

Limited enrollment. Tour and study of production methods in major crop and livestock regions of the world. Influence of climate, economics, geography, soils, landscapes, markets, and other factors on crop and livestock production. Location and duration of tours will vary. Tour expenses paid by students. Check with department for current offerings. Meets International Perspectives Requirement.

AGRON 496B: Domestic Tour

Cr. arr. Repeatable.

Prereq: Permission of instructor

Limited enrollment. Tour and study of production methods in major crop and livestock regions of the world. Influence of climate, economics, geography, soils, landscapes, markets, and other factors on crop and livestock production. Location and duration of tours will vary. Tour expenses paid by students. Check with department for current offerings.

AGRON 497: Agroecology Field Course

(3-0) Cr. 3. F.

Prereq: Jr. or Sr. classification with at least 8 credits in Agronomy

A one-week intensive class, offered off-campus. Student will visit farms within the Midwest and analyze the sustainability of each farm.

AGRON 498: Cooperative Education

Cr. R. F.S.SS.

Prereq: Permission of faculty member or student's adviser; senior classification

Students register for this course in order to retain full-time status while on a professional work experience. Students must register for this course prior to commencing each work period. Offered on a satisfactory-fail basis only.

Courses primarily for graduate students, open to qualified undergraduates:**AGRON 500: Orientation Seminar**

(2-0) Cr. 1. F.

Prereq: International agronomy graduate students only

An introduction to Iowa and U.S. agriculture for international scholars in agronomic majors. Field trips when possible. Departmental role in the functioning of research, teaching, and extension in fulfilling the charge given the land-grant university.

AGRON 501: Crop Growth and Development

(3-0) Cr. 3. F.S.

Prereq: AGRON 181 or equivalent, MATH 140, CHEM 163, BIOL 101

Physiological processes in crop growth, development and yield: photosynthesis, respiration, water relations, mineral nutrition, assimilate partitioning, seedling vigor, light interception and canopy growth, root growth, reproduction and yield. Required course for the Master of Science in Agronomy degree program and Agronomy Graduate Certificate program.

AGRON 502: Chemistry, Physics, and Biology of Soils

(3-0) Cr. 3. F.Alt. S., offered odd-numbered years.

Prereq: AGRON 181 or equivalent, AGRON 182 or equivalent, BIOL 101, CHEM 163, MATH 140

Soil chemical, physical, and biological properties that control processes within the soil, their influence on plant/soil interactions, and soil classification. Basic concepts in soil science and their applications. Required course for the Master of Science in Agronomy degree program and Agronomy Graduate Certificate program.

AGRON 503: Climate and Crop Growth

(3-0) Cr. 3. F.S.

Prereq: AGRON 181 or equivalent and MATH 140

Applied concepts in climate and agricultural meteorology with emphasis on the climate-agriculture relationship and the microclimate-agriculture interaction and crop risk management. Basic meteorological principles are also presented to support these applied concepts. Required course for the Master of Science in Agronomy degree program and Agronomy Graduate Certificate program.

AGRON 504: Global Change

(Dual-listed with AGRON 404). (Cross-listed with ENSCI, MTEOR). (3-0) Cr. 3. S.

Prereq: Four courses in physical or biological sciences or engineering; junior standing

Recent changes in global biogeochemical cycles and climate; models of future changes in the climate system; impacts of global change on agriculture, water resources and human health; ethical issues of global environmental change. Also offered online Alt. F, even-numbered years.

AGRON 505: Environmental Biophysics

(Dual-listed with AGRON 405). (Cross-listed with ENSCI, MTEOR). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: MATH 165 and some exposure to computer programming (any language)

The movement of energy and mass among the soil, vegetation, and atmosphere. The heat and water budget of humans, other animals, plants, and plant communities. Relevance to weather and climate, the effect of climate change on organisms, and remote sensing.

AGRON 506: Crop Genetics

(Cross-listed with HORT). Cr. 3. F.

Introduction to genetics of reproductive systems, recombination, segregation and linkage analysis, inbreeding, quantitative inheritance, fertility regulation, and polyploidy to prepare students for subsequent courses in crop improvement. Enrollment is restricted to off-campus MS in Plant Breeding students.

AGRON 507: Mesoscale Meteorology

(Dual-listed with AGRON 407). (Cross-listed with MTEOR). (3-0) Cr. 3. Alt. S., offered even-numbered years.

Prereq: Math 166 and Mteor 454

The physical nature and practical consequences of mesoscale atmospheric phenomena. Mesoscale convective systems, fronts, terrain-forced circulations. Observation, analysis, and prediction of mesoscale atmospheric structure. Semester project and in-class presentation required.

AGRON 508: Biophysical Crop Ecology

(3-0) Cr. 3. Alt. S., offered even-numbered years.

The physics behind how humans use plant photosynthesis to convert energy from the sun into useful products. Techniques for quantifying and predicting ecological interactions in the soil-plant-atmosphere continuum.

AGRON 509: Agroecosystems Analysis

(Cross-listed with SOC, SUSAG). (3-4) Cr. 4. F.

Prereq: Senior or above classification; permission of instructor

Experiential, interdisciplinary examination of Midwestern agricultural and food systems, emphasizing both field visits and classroom activities. Focus on understanding multiple elements, perspectives (agronomic, economic, ecological, social, etc.), and scales of operation.

AGRON 510: Crop Improvement

(Cross-listed with STB). (3-0) Cr. 3.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

A study of the basic principles and methods in the genetic improvement of crop plants. Methods used in manipulating genomes through the use of biotechnology. Methods of cultivar development. Quantitative procedures for describing response to selection. Analysis of the relationship of reproductive characters and growth characteristics to response to selection.

AGRON 511: Crop Improvement

(3-0) Cr. 3. F.S.

Prereq: AGRON 181 or equivalent, MATH 140, CHEM 163, BIOL 101

Basic principles in the genetic improvement of crop plants. Methods of cultivar development in self-pollinated and cross-pollinated crop species. Required course for the Master of Science in agronomy degree program and agronomy graduate certificate program.

AGRON 512: Soil-Plant Environment

(3-0) Cr. 3. S.

Prereq: AGRON 502. Recommended AGRON 501

Soil properties and their impact on soil/plant relationships. Soil structure, aeration, moisture, and nutrients will be discussed in the context of soil fertility and environmental quality management. Required course for the Master of Science in agronomy degree program and agronomy graduate certificate program.

AGRON 513: Quantitative Methods for Agronomy

(3-0) Cr. 3. F.S.

Prereq: AGRON 181 or equivalent, MATH 140, STAT 104

Quantitative methods for analyzing and interpreting agronomic information. Principles of experimental design, hypothesis testing, analysis of variance, regression, correlation, and graphical representation of data. Use of SAS and Excel for organization, analyzing, and presenting data. Required course for the Master of Science in Agronomy degree program.

AGRON 514: Integrated Pest Management

(3-0) Cr. 3. F.S.

Prereq: AGRON 181 or equivalent, AGRON 501, MATH 140, CHEM 163, BIOL 101; AGRON 502 and AGRON 503 recommended

Principles and practices of weed science, entomology, and plant pathology applied to crop production systems. Biology, ecology and principles of integrated crop pest management. Required course for the Master of Science in Agronomy degree program and Agronomy Graduate Certificate program.

AGRON 515: Integrated Crop and Livestock Production Systems

(Cross-listed with A B E, AN S, SUSAG). (3-0) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: SUSAG 509

Methods to maintain productivity and minimize the negative ecological effects of agricultural systems by understanding nutrient cycles, managing manure and crop residue, and utilizing multispecies interactions. Crop and livestock production within landscapes and watersheds is also considered. Course includes a significant field component, with student teams analyzing Iowa farms.

AGRON 516: Crop Physiology

(3-0) Cr. 3. S.

Investigation of Molecular, whole plant, and plant community processes essential to biomass production and seed formation, and analysis of molecular approaches to overcome the limitations imposed on these processes by the environment.

AGRON 518: Microwave Remote Sensing

(Cross-listed with E E, MTEOR). (3-0) Cr. 3. Alt. S., offered even-numbered years.

Prereq: Math 265

Microwave remote sensing of Earth's surface and atmosphere using satellite-based or ground-based instruments. Specific examples include remote sensing of atmospheric temperature and water vapor, precipitation, ocean salinity, and soil moisture.

AGRON 519: Herbicide Physiology and Biochemistry

(2-0) Cr. 2. Alt. S., offered even-numbered years.

Prereq: AGRON 316 (or equivalent) and AGRON 317

Herbicide mechanisms of action, selectivity, uptake, and translocation. Specific sites of herbicide action as they affect plant physiology. Herbicide resistance in weeds and crops. Implications of herbicides on weed management.

AGRON 520: Plant Breeding Methods

Cr. 3. S.

Prereq: AGRON 506

Breeding methods used in the genetic improvement of self-pollinated, cross-pollinated and clonal crops.

AGRON 521: Principles of Cultivar Development

(3-0) Cr. 3. F.

Prereq: AGRON 421 and STAT 401

Theoretical and practical exploration of breeding methods to develop clonal, pureline, inbred and hybrid cultivars. Principles and strategies to set breeding objectives, parental selection and germplasm management, population development, generation advancements, multiple trait selection, experimental designs in breeding programs; seed production and certification. Introduce tools available to a breeder.

AGRON 522: Field Methods in Plant Breeding

(0-6) Cr. 1-2. Alt. SS., offered odd-numbered years.

Prereq: AGRON 521

Field experience in planning and conducting plant breeding research for germplasm and cultivar development. Offered on a satisfactory-fail basis only.

AGRON 523: Molecular Plant Breeding

(2-2) Cr. 3. S.

Prereq: AGRON 421 or AGRON 521, GDCB 542A

Plant breeding in the era of sequenced genomes and transformation. High throughput genomic technologies will be presented in relation to various applications in plant breeding.

AGRON 524: Applied Plant Molecular Genetics & Biotechnology

Cr. 3. F.

Prereq: AGRON 506

Basic principles and applied techniques used in the genetic improvement of crop plants. Discussion of structure and function of genes that control traits of value. Types of molecular markers, analysis of quantitatively inherited traits, genome mapping, analyses of databases.

AGRON 525: Crop and Soil Modeling

(3-0) Cr. 3. F.

Prereq: MATH 165 or Math 181 or equivalent; AGRON 316 or Agron 354 or equivalent.

Understanding basic crop physiology and soil processes through the use of mathematical and statistical approaches. Structure of crop models, dynamics and relationship among components such as leaf-level photosynthesis, canopy architecture, root dynamics and soil carbon and nitrogen pools.

AGRON 526: Field Plot Technique

(3-2) Cr. 4. S.

Prereq: STAT 401

Planning experiments for agricultural research, analysis of data, and concepts in data interpretation.

AGRON 528: Quantitative Genetics for Plant Breeding

(3-0) Cr. 3. S.

Prereq: AGRON 506 or AGRON 513

An introduction to the application of quantitative genetics to plant breeding programs.

AGRON 530: Ecologically Based Pest Management Strategies

(Cross-listed with ENT, PL P, SUSAG). (3-0) Cr. 3. Alt. F., offered even-numbered years.

Durable, least-toxic strategies for managing weeds, pathogens, and insect pests, with emphasis on underlying ecological processes.

AGRON 531: Crop Ecology and Management

(3-0) Cr. 3. F.

Prereq: AGRON 501, AGRON 502, AGRON 503; AGRON 512 and AGRON 514 recommended

Ecological principles underlying crop production systems. Crop production in the context of management approaches, system resources and constraints, and interactions. Emphasis on the ecology of row and forage crops common to the Midwest. Required course for the Master of Science in Agronomy degree program.

AGRON 532: Soil Management

(3-0) Cr. 3. F.

Prereq: AGRON 501, AGRON 503, AGRON 512. Recommended AGRON 513

Evaluates the impact of various soil management practices on soil and water resources. Combines and applies basic information gained in Agron 502 and Agron 512. Emphasizes the agronomic, economic, and environmental effects of soil management strategies. Required course for the Master of Science in Agronomy degree program.

AGRON 533: Crop Protection

(3-0) Cr. 3. F.SS.

Prereq: AGRON 514

Integrated management systems for important crop pests. Cultural, biological and chemical management strategies applicable to major crops grown in the Midwest. Required course for the Master of Science in Agronomy degree program.

AGRON 534: Seed and Variety, Testing and Technology

(Cross-listed with STB). (2-0) Cr. 2.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

The components of seed quality and how they are assessed in the laboratory, including traits derived from modern biotechnology. The impact of new technologies on seed quality testing. Variety maintenance procedures and breeder seed. Variety identification: phenotype and grow-out trials, isozyme testing, and DNA marker testing. Procedures for evaluating varieties. The variance tests appropriate for fixed effects analysis of variance. Statistical inference and stratification for yield trials. Use of strip plot testing.

AGRON 535: Introduction to the Seed Industry

(Cross-listed with STB). Cr. 1.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

An analysis of the defining characteristics of the seed industry and introduction to the Master in Seed Technology and Business curriculum. The tasks of crop improvement and seed production will be analytically related to basic management functions and classifications of management activities. Management tasks and roles will be analyzed and related to the public policy issues that shape the seed industry. Current issues in the seed industry including ethical and economical approaches to biotechnology, intellectual property, and corporate responsibility will be discussed.

AGRON 536: Quantitative Methods for Seed

(Cross-listed with STB). (2-0) Cr. 2. F.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

Quantitative Methods for analyzing and interpreting agronomic and business information for the seed industry. Principles of experimental design and hypothesis testing, regression, correlation, analysis of variance, and graphical representation of data. Use of spreadsheets and statistical software for manipulating, analyzing and presenting data.

AGRON 538: Seed Physiology and the Environment

(Cross-listed with HORT). (2-0) Cr. 2. Alt. F., offered even-numbered years.

Prereq: AGRON 316; CHEM 231 or CHEM 331

Physiological aspects of seed development, maturation, longevity, dormancy, and germination of agronomic and horticultural crops and their interactions with field and storage environments. Emphasis on current literature and advanced methodology.

AGRON 539: Seed Conditioning and Storage

(Cross-listed with STB). (2-0) Cr. 2.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

The technical operations which may be carried out on a seed lot from harvest until it is ready for marketing and use. The opportunities for quality improvement and the risks of deterioration which are present during that time. Analysis of the costs of and benefits of operations. Evaluation of equipment based on benefits to the customer and producer. Interpretation of the role of the conditioning plant and store as a focal points within the overall operations of a seed company.

AGRON 541: Applied Agricultural Meteorology

Cr. 2-3. F.S.SS.

Prereq: AGRON 206 or upper division Biological Science

Applied concepts in agricultural meteorology. Basic concepts of weather and of crop/climate relationships influencing production, protection, yield and associated production risk factors. Self study sections are available to resident and to distant education students all semesters. Credit for only one of Agron 503 or 541 may be applied toward graduation.

AGRON 544: Host-Pest Interactions

Cr. 3. F.

Prereq: AGRON 501

Incorporation of the principles of integrated pest management and crop protection. Management systems (biological, cultural, chemical) and strategies which practice principles of weed science, plant pathology, and entomology. Enrollment is restricted to off-campus students in Agronomy MS in Plant Breeding.

AGRON 546: Strategies for Diversified Farming Systems

(Cross-listed with HORT, SUSAG). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: SUSAG 509

Project-focused engagement in food and farming systems using tools and perspectives drawn from multiple disciplines. Includes a field component.

AGRON 547: Seed Production

(Cross-listed with STB). (2-0) Cr. 2.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

Survey of crop production; including management of soil fertility, planting dates, populations, weed control, and insect control. Analysis of the principles of seed multiplication and the key practices which are used to ensure high quality in the products. Field inspection procedures and production aspects that differ from other crop production. Foundation seed production. Analysis of the typical organization of field production tasks. Survey of the differences in seed production strategies between crops and the impact of these differences on seed production.

AGRON 551: Growth and Development of Perennial Grasses

(Cross-listed with HORT). (2-0) Cr. 2. Alt. S., offered even-numbered years.

Prereq: Junior or senior or graduate classification or permission of instructor

Selected topics on anatomy, morphology, and physiology relative to growth and development of perennial grasses. Emphasis on growth and development characteristics peculiar to grasses and variations of such characteristics under natural and managed conditions.

AGRON 552: GIS for Geoscientists

(Dual-listed with AGRON 452). (Cross-listed with ENSCI, GEOL). (2-2) Cr. 3. F.S.

Prereq: GEOL 100, GEOL 201 or equivalent

Introduction to geographic information systems (GIS) with particular emphasis on geoscientific data. Uses ESRI's ArcGIS Desktop Software and extension modules. Emphasizes typical GIS operations and analyses in the geosciences to prepare students for advanced GIS courses.

AGRON 553: Soil-Plant Relationships

(Cross-listed with ENSCI). (3-0) Cr. 3. S.

Prereq: AGRON 354

Composition and properties of soils in relation to the nutrition and growth of plants.

AGRON 554: Advanced Soil Management

(2-0) Cr. 2. Alt. F., offered odd-numbered years.

Prereq: AGRON 354; MATH 165

Implications of soil management on the soil environment and root activity. Effect of soil physical properties on soil erosion.

AGRON 555: Environmental Soil Mineralogy

(Cross-listed with GEOL). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: AGRON 473, CHEM 178. Recommend: GEOL 311

Structure and behavior of clay minerals, humic substances and biochar in soil environments, with emphasis on reactions and environmental implications.

AGRON 556: Agroecosystem Nutrient Cycles

(3-0) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: 3 credits in chemistry and 6 credits in biology; Recommended: ENSCI 382, ENSCI 553, or upper-level coursework in nutrient cycles

Major, biologically important agroecosystem nutrient cycles as linked to energy (carbon) and water. Effects of agricultural production and management on cycling within systems and transfer among system at local, regional and global scales will be emphasized.

AGRON 558: Laboratory Methods in Soil Chemistry

(Cross-listed with ENSCI). (2-3) Cr. 3. Alt. F., offered even-numbered years.

Prereq: AGRON 354 and CHEM 211

Experimental and descriptive inorganic and organic analyses. Operational theory and principles of applicable instruments, including spectrophotometry, atomic and molecular absorption and emission spectroscopy, mass spectrometry, X-ray diffraction and fluorescence, gas and ion chromatography, and ion-selective electrodes.

AGRON 559: Environmental Soil and Water Chemistry

(Dual-listed with AGRON 459). (Cross-listed with ENSCI). (3-3) Cr. 4. F.

Prereq: Two semesters of college-level chemistry, MATH 140, AGRON 182 (or equivalent) or AGRON 360; GEOL 100 and AGRON 354 recommended

An introduction to the chemical properties of soils, chemical reactions and transformations in soils and surface waters, and their impact on the environment. Topics include solution chemistry in soils and surface waters, solid-phase composition of soils, reactions at the solid-solution interface, and applications to contemporary environmental issues.

AGRON 561: Population and Quantitative Genetics for Breeding

(Cross-listed with AN S). (4-0) Cr. 4. F.

Prereq: STAT 401

Population and quantitative genetics for plant and animal genetics. Study of the genetic basis and analysis of variation in quantitative traits in domestic or experimental populations using phenotypic and molecular marker data, including estimation of heritability and other genetic parameters, linkage analysis and mapping of quantitative trait loci, and the impact of inbreeding, heterosis, and genotype-by-environment interaction.

AGRON 563: Soil Formation and Landscape Relationships

(Dual-listed with AGRON 463). (Cross-listed with ENSCI). (3-0) Cr. 3. S.

Prereq: AGRON 182 (or equivalent) or AGRON 260

Relationships between soil formation, geomorphology, and environment. Soil description, classification, geography, mapping, and interpretation for land use. Two weekend field trips. Credit for one of AGRON 463 or AGRON 463I may be applied for graduation.

AGRON 563I: Soil Formation and Landscape Relationships

(Dual-listed with AGRON 463I). (Cross-listed with ENSCI, IA LL). Cr. 2. Alt. SS., offered even-numbered years.

Prereq: AGRON 182 (or equivalent)

Relationships between soil formation, geomorphology, and environment. Soil description, classification, geography, mapping, and interpretation for land use. Credit for only Agron 563 or 563I may be applied for graduation.

AGRON 570: Risk Assessment for Food, Agriculture and Veterinary Medicine

(Cross-listed with TOX, VDPAM). (3-0) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: Statistics 300-level or higher.

Risk assessment principles as applied to biological systems. Exposure and effects characterization in human and animal health and ecological risk assessment. Risk analysis frameworks and regulatory decision-making. Introduction to quantitative methods for risk assessment using epidemiological and distributional analysis. Uncertainty analysis.

AGRON 575: Soil Formation and Transformation

(Cross-listed with ENSCI). (3-0) Cr. 3. F.

Prereq: AGRON 463 or equivalent

Advanced study of soil formation, emphasizing relationships among soils, landscapes, environment, humans, and land use.

AGRON 577: Soil Physics

(Dual-listed with AGRON 477). (Cross-listed with ENSCI). (3-0) Cr. 3. S.

Prereq: AGRON 182 or equivalent and MATH 166 recommended

The physical soil system: the soil components and their physical interactions; transport processes involving water, air, and heat.

AGRON 578: Laboratory Methods in Soil Physics

(Cross-listed with ENSCI). (0-3) Cr. 1. S.

Prereq: concurrent enrollment in AGRON 477 or AGRON 577

Methods of measuring soil physical properties such as texture, density, and water content, and transport of heat, water, and gases.

AGRON 584: Organic Agricultural Theory and Practice

(Dual-listed with AGRON 484). (Cross-listed with HORT, SUSAG). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: 9 cr. in biological or physical sciences

Understanding of the historical origins and ecological theories underpinning the practices involved in organic agriculture. Interdisciplinary examination of crop and livestock production and socio-economic processes and policies in organic agriculture from researcher and producer perspectives.

AGRON 585: Soil and Environmental Microbiology

(Dual-listed with AGRON 485). (Cross-listed with ENSCI, MICRO). (2-3) Cr. 3. F.

Prereq: AGRON 182 or equivalent; MICRO 201 and MICRO 201L recommended

The living organisms in the soil and what they do. Emphasis on soil biota composition, the carbon cycle and bioremediation, soil-plant-microbial relationships, and environmental issues.

AGRON 588: GIS for Geoscientists II

(Dual-listed with AGRON 488). (Cross-listed with ENSCI, GEOL). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: GIS course, such as GEOL 452, CRP 451, CRP 452, NREM 345, NREM 446, AE 408 or equivalent

GIS course with focus on the spatial analysis and modeling of raster data and triangulated irregular network (TIN) data. Uses ArcGIS and various extensions, such as Spatial Analyst, 3D Analyst, and ArcScene. Includes practical exercises during lectures, lab exercises, homework assignments, and (for GEOL 588) a class project.

AGRON 590: Special Topics

Cr. arr. Repeatable.

Prereq: 15 credits in agronomy

Literature reviews and conferences on selected topics in crops, soils, or agricultural meteorology according to needs and interest of student.

AGRON 591: Agronomic Systems Analysis

(3-0) Cr. 3. S.

Prereq: AGRON 511, AGRON 513, AGRON 531, AGRON 532, AGRON 533

Analysis of cropping systems from a problem-solving perspective. Case studies will be used to develop the students' ability to solve agronomic problems. Required course for the Master of Science in Agronomy degree program.

AGRON 592: Current Issues in Agronomy

(3-0) Cr. 3. F.S.

Prereq: AGRON 501, AGRON 503, AGRON 511, AGRON 512, AGRON 513, AGRON 514

Critical analysis and discussion of agricultural practices, programs, and policies of current interest to the field of agronomy. Leadership skill development through consideration of technical, social, and ethical components underlying controversial topics. Enhancement of communication proficiency through debate and writing in order to define problems, articulate possible solutions, and propose appropriate courses of action. Required course for the Master of Science in agronomy degree program.

AGRON 593: Workshop in Agronomy

Cr. arr. Repeatable.

Prereq: Graduate classification

AGRON 594: Agronomy MS Practicum

(1-0) Cr. 1. SS.

Prereq: AGRON 501, AGRON 502, AGRON 503, AGRON 514 (or current enrollment. Recommended: AGRON 511, AGRON 512, AGRON 513

Practical field and laboratory experiences integrating coursework in climatology, crops, and soils. Includes lectures, labs and local agri-business tours.

AGRON 595: Seed Quality, Production, and Research Management

(Cross-listed with STB). (3-0) Cr. 3.

Prereq: Admission to the Graduate Program in Seed Technology and Business or approval of instructor must be obtained.

Advanced survey of the organization, staff capabilities and management characteristics typical in seed production and crop improvement in seed enterprises. Analysis of the use of quality information in the management of seed operations and sales. Process management applications for seed. Production planning for existing capacity. Analysis of the manager's tasks in the annual cycle and how the tasks of these managers relate to the general categories of business management roles. Difference in management strategies used with different situations and groups of employees.

AGRON 599: Creative Component

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599A: Agricultural Meteorology

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599B: Crop Production and Physiology

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599C: Plant Breeding

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599D: Soil Chemistry

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599E: Soil Fertility

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599F: Soil Management

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599G: Soil Microbiology and Biochemistry

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599H: Soil Morphology and Genesis

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599I: Soil Physics

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599K: Seed Science

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599L: Weed Science

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

AGRON 599M: Agronomy

Cr. arr.

Prereq: Nonthesis M.S. option only

A written report based on research, library readings, or topics related to the student's area of specialization and approved by the student's advisory committee.

Courses for graduate students:**AGRON 600: Seminar**

(1-0) Cr. 1. Repeatable, maximum of 6 times. F.S.

Reports and discussion of recent literature and research.

AGRON 600A: Seminar: Plant Breeding

(1-0) Cr. 1. Repeatable, maximum of 6 times. S.

Instruction and practice in giving scientific presentations related to the fields of plant breeding, genetics, or genomics, with an emphasis on effective communication and presentation techniques.

AGRON 600B: Seminar: Soils

(1-0) Cr. 1. Repeatable, maximum of 6 times. S.

Reports and discussion of recent literature and research.

AGRON 600C: Seminar: Crop Production and Physiology

(1-0) Cr. 1. Repeatable, maximum of 6 times. F.S.

Reports and discussion of recent literature and research.

AGRON 601: Agronomic Science Presentations

(3-0) Cr. 2. S.

Prereq: graduate status in agronomic science, permission of instructor.

Experience in critical communications in exchange of ideas through oral and poster presentations and scientific questioning/evaluation.

AGRON 605: Boundary-Layer Meteorology

(Cross-listed with MTEOR). (3-0) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: MTEOR 443 or equivalent-level course in engineering fluids

Atmospheric boundary-layer structure and dynamics. Diurnal and seasonal variations, turbulent fluxes and turbulence kinetic energy.

Measurements and empirical relations for wind and temperature near the ground. Numerical simulation and applications to wind energy.

AGRON 610: Foundations of Sustainable Agriculture

(Cross-listed with A B E, ANTHR, SOC, SUSAG). (3-0) Cr. 3. F.

Prereq: Graduate classification, permission of instructor

Historical, biophysical, socioeconomic, and ethical dimensions of agricultural sustainability. Strategies for evaluating existing and emerging agricultural systems in terms of the core concepts of sustainability and their theoretical contexts.

AGRON 621: Advanced Plant Breeding

(3-0) Cr. 3. S.

Prereq: AGRON 521, AGRON 526, AGRON 561, GEN 410

Genetics of breeding populations, means of genotypes and breeding populations, mapping quantitative trait loci, variation in breeding populations, genetic design, genotype by environment interaction, selection in breeding populations, recurrent selection, marker-assisted selection, best linear unbiased prediction, genome-wide association studies, genomic selection, heterosis and hybrid prediction, and multiple traits.

AGRON 625: Genetic Strategies in Plant Breeding

(3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: AGRON 521 and GDCB 510

Evaluation of genetic, molecular, and cellular approaches to crop improvement; gene transfer methods. Application and role of basic plant biology in breeding programs and processes; genome structure and function, gene isolation, expression, regulation, and modification. Integration of molecular and cellular methods in breeding strategies; analysis of alternative breeding methods, regulatory and ethical issues.

AGRON 655: Advanced Soil Fertility

(2-0) Cr. 2. Alt. S., offered odd-numbered years.

Prereq: AGRON 553

Evaluation of soil fertility and fertilizers; theory and applications.

AGRON 677: Advanced Soil Physics

(2-0) Cr. 3. Alt. F., offered even-numbered years.

Prereq: AGRON 577 and MATH 266; COM S 207 recommended

The flow and distribution of water, chemicals, and heat in soils. Physical principles and applications.

AGRON 685: Advanced Soil Biochemistry

(Cross-listed with ENSCI, MICRO). (2-0) Cr. 2. Alt. S., offered even-numbered years.

Prereq: AGRON 585

Chemistry of soil organic matter and biochemical transformations brought about by microorganisms and enzymes in soils.

AGRON 696: Research Seminar

(Cross-listed with BBMB, FOR, GDCB, HORT, PLBIO). Cr. 1. Repeatable.

Research seminars by faculty and graduate students. Offered on a satisfactory-fail basis only.

AGRON 698: Agronomy Teaching Practicum

Cr. 1-2. Repeatable. F.S.SS.

Prereq: Graduate classification in agronomy and permission of instructor

Graduate student experience in the agronomy teaching program. Offered on a satisfactory-fail basis only.

AGRON 699: Research

Cr. arr. Repeatable.

AGRON 699A: Agricultural Meteorology

Cr. arr. Repeatable.

AGRON 699B: Crop Production and Physiology

Cr. arr. Repeatable.

AGRON 699C: Plant Breeding

Cr. arr. Repeatable.

AGRON 699D: Soil Chemistry

Cr. arr. Repeatable.

AGRON 699E: Soil Fertility

Cr. arr. Repeatable.

AGRON 699F: Soil Management

Cr. arr. Repeatable.

AGRON 699G: Soil Microbiology and Biochemistry

Cr. arr. Repeatable.

AGRON 699H: Soil Morphology and Genesis

Cr. arr. Repeatable.

AGRON 699I: Soil Physics

Cr. arr. Repeatable.

AGRON 699J: Plant Physiology

Cr. arr. Repeatable.

AGRON 699K: Seed Science

Cr. arr. Repeatable.

AGRON 699L: Weed Science

Cr. arr. Repeatable.